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Assessment of Fish Stocks in Lake Diefenbaker 2010

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ASSESSMENT OF FISH STOCKS IN LAKE DIEFENBAKER, 2010

Fish and Wildlife Technical Report 2010-1

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INTRODUCTION

Lake Diefenbaker was created on the South Saskatchewan River in the late 1960s by the construction of two large earth fill dams, the main Gardiner Dam and a secondary dam across the Qu'Appelle Valley. The reservoir was initially built as a large water storage area in the arid southwest region of the province for irrigation, hydro-electric power production, flood control, recreation and rural and urban water supplies (Royer 1972). The Gardiner Dam provides water for power generation at Coteau Creek Power Station. The Qu'Appelle Dam allows water diversion into the Qu'Appelle – Assiniboine River system.

Although originally designed for water storage, Lake Diefenbaker has greatly increased the recreational and angling opportunities in the southern part of the province. Three provincial parks have become established on the reservoir: Danielson, Douglas and Saskatchewan Landing (Fig. 1). Numerous other regional parks, cottage subdivisions and camps are situated along the shoreline. Yachting, water-skiing, boating, angling and camping are all popular activities. Tournament fishing (catch and release) for walleye and sauger began in the summer of 1991 at Riverhurst. Additional tournaments are now held annually at Saskatchewan Landing and Elbow. Lake Diefenbaker has become renown throughout the prairie provinces and northern states as a prime sport fishery. The 2000 Survey of Sport Fishing in Saskatchewan, a joint federal – provincial angler survey carried out every 5 years, ranked Lake Diefenbaker as the top destination for sport fishing (Duffy 2006). Information from the 2005 survey was not available. In addition to its famous walleye fishery, trophy trout have also been angled from this lake. In 1996, a 37 lb brown trout was taken by spear fishing. More recently, a record 43.6 lb rainbow trout was angled in 2007.

Twenty-five species of fish were captured in the original fisheries assessment carried out by Royer (1972). The principal game species include pike, walleye, sauger, whitefish, goldeye, and perch. The origin of rainbow trout, lake trout and whitefish is uncertain; however, speculation is that they moved into the reservoir from headwater regions of the drainage system in Alberta. Walleye, whitefish and lake trout, present in meager numbers prior to 1969, were stocked between 1969 and 1975. In recent years, escapes of fish from an existing rainbow trout aquaculture operation have increased the abundance of this species in the reservoir. Appendix 1 provides a list of stocked fish up to 2004.

Spawn taking operations for walleye began in 1991 after testnetting in 1983 revealed large populations of walleye along the Gardiner Dam. Eggs are collected from spawning walleye within Coteau Bay during late April – early May. Limited numbers of pike eggs are also

collected during the camp. The fertilized eggs are then transported to the Fish Culture Station in Fort Qu'Appelle and raised to the fry stage. The walleye fry are distributed to hundreds of lakes within Saskatchewan to increase angling opportunities throughout the province. A minimum of 5% of the total fry hatch each year is restocked into Coteau Bay to compensate for any losses in fish production as a result of spawn-taking operations. Since 2004, fry have also been stocked in the Saskatchewan Landing area due to concerns about walleye populations in these upper reaches of the reservoir.

A commercial fishery for whitefish operated on Lake Diefenbaker during the fall from 1978 to 1986. The fishery was then closed due to a reduction in both size and number of whitefish taken. There were additional concerns with the numbers of gamefish captured during the fishery.

The initial fisheries assessment on Lake Diefenbaker was carried out from 1967 to 1969 to document physical, chemical and biological characteristics of the newly formed reservoir, and to provide baseline information in order to develop a preliminary fish management plan. Additional investigations occurred in 1973 to update information on the fish populations. Since that time, routine sport fish management investigations have been carried out in 1977, 1980, 1988, 1992 and 1995. Further assessments, including a walleye tagging study, were carried out from 2001 to 2003 to determine the impact of spawn-taking operations on walleye. Results from this study suggested that the spawning walleye population in the lower reaches of Lake Diefenbaker in the Coteau Bay area was in a healthy state (Wallace and Jensen 2004).

Concerns over the status of gamefish populations, lack of angler success in some areas of the reservoir, reports of small size of walleye and sauger in the Saskatchewan Landing area and increased pressure on the fish resources resulted in an assessment of the fish populations in Lake Diefenbaker during 2004. Objectives of the study included:

- Assessment of the fish populations in Lake Diefenbaker, particularly in the Saskatchewan Landing area;
- Comparison of the present status of the fishery resource to results obtained in past surveys;
- Determination of angling activities and patterns over the summer months in 2004;
- Determination of the extent of walleye-sauger hybridization;
- Recommendations pertaining to any management changes necessary to ensure the resources are maintained in a healthy state.

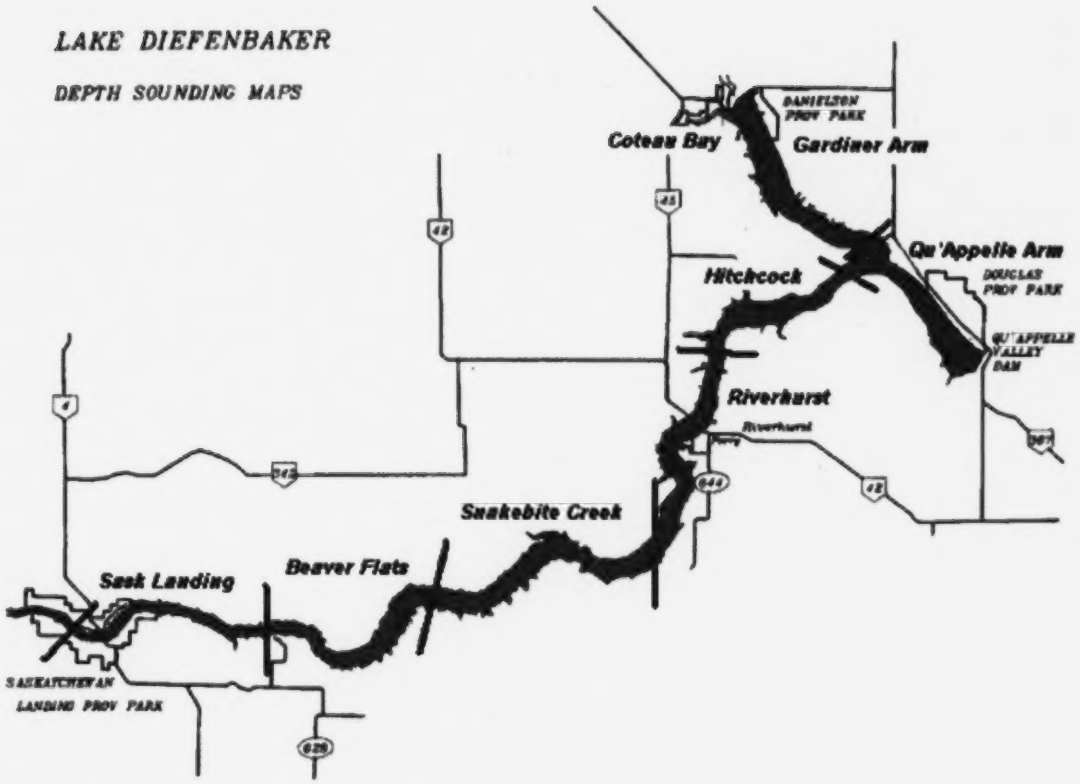


Figure 1. Map of Lake Diefenbaker showing provincial parks and recreational developments. The regional zones were the areas used for updating the depth contours in 1985.

DESCRIPTION OF STUDY AREA

Hydrology

The South Saskatchewan River lies in a wide meltwater valley cut 60 to 150 meters into the glacial deposits and sandy soils of the Missouri Coteau (Richards and Fung 1969). The western end of Lake Diefenbaker shows evidence of this deep valley, while the middle and eastern areas reveal sandy and glacial till from erosion along their shorelines.

Inflows into Lake Diefenbaker come primarily from the South Saskatchewan River, mainly from drainage areas in southern Alberta. The Oldman, Bow and Red Deer Rivers and associated mountain headwaters provide approximately 90% of the inflow (SEPS/EC 1988). Additional inflows come from local tributaries such as Swift Current and Richardson Creeks.

Outflows from Lake Diefenbaker are dependent on hydroelectric demands on the Coteau Creek Power Station, predictions from inflow patterns as well as requirements for downstream flows. Water is also released at the east end of the Gardiner Dam to be used in the Outlook area and in the Saskatoon South-East Water Supply Project (SSEWS). The SSEWS is a series of six reservoirs connected by canals and pipelines that supplies water to towns, potash mines and irrigation, wildlife and recreation projects. Small releases also occur through the Qu'Appelle River Dam to improve amount and quality of water in the Qu'Appelle River system.

In its western upstream end in the Saskatchewan Landing area, the reservoir exhibits riverine characteristics such as water currents and periodic mixing as far downstream as Riverhurst. Further downstream, currents are negligible, warming of surface water occurs and weak to moderate thermoclines can develop. The deepest water can be 4 to 10°C cooler than surface waters from July to September (ILEC 1999).

Lake Diefenbaker has average annual water level fluctuations of about 7.5 m (SEPS/EC 1988). The ice-free period is approximately April 20 until November 30. Winter drawdowns of about 5 m occur from November until March for hydro-electric generation. Water levels are lowest in spring, increasing in late May to July when glacial melt-waters arrive from Alberta.

Morphometry

Lake areas and volumes were determined from earlier surveys (Royer 1972). Two depth maps were prepared during different surveys, both of which had depths adjusted to full supply level of 556.86 m. The initial map was prepared using landscape topography contours prior to filling of the reservoir (Royer 1972). The second map (see Fig. 1) was prepared using echo-soundings taken during 1985, following 15 years where slumping of headlands, erosion of shorelines, deposition of river sediments, and shifting of lake bottom may have occurred (SCSMA 1986).

Morphometric parameters of six regions of the lake are provided in Table 1a, based on information collected by Royer (1972). Areas of each depth stratum were recalculated from maps based on echo-soundings in 1985 by scanning and counting digital areas (SCSMA 1986), using software GIMP 2.2 (Table 1b).

Diefenbaker Lake covers a surface are of 477 km^2, including the 'headwater region' which extends from Saskatchewan Landing upriver past Cabri Regional Park. Maximum depths increase rapidly from 6 m in the 'headwaters' to 22 m in the Saskatchewan Landing region and to 44 m by Riverhurst Ferry. There are no islands or known shoals along the length of the reservoir. Mid-channel is over 15 m deep continuously from 5 km east of Saskatchewan Landing and over 30 m deep from 3 km west of Herbert Ferry to the Gardiner Dam. The Qu'Appelle Arm is slightly shallower, with about half of its mid-channel depth exceeding 30 m. Maximum depth is recorded at 59.4 m, located within the Gardiner Arm.

METHODS

Physical and Chemical Parameters

In 2004, readings of surface water chemistry and temperature-oxygen profiles were recorded periodically near testnet locations and also in areas of open water. Temperature and oxygen data were obtained every few metres throughout the water column, using a YSI handheld meter. Increased readings were taken at depths where rapid changes were observed. Conductivity and pH were measured using a handheld meter. Water clarity was measured using a black and white 20 cm secchi disk.

Water-level graphs and data for 2004 and previous years were obtained from the Water Survey of Canada website and HYDAT database for Lake Diefenbaker at Gardiner Dam (station

05HF003, period of record 1964 to 2004, located at 51°16'49" N and 106°50'18" W, based on PFRA datum, see Environment Canada 2005a and 2005b).

Assessment of the Fish Resources

Fisheries surveys have typically used standard gang gill-nets, each consisting of six panels of multifilament nylon mesh with stretched measurements of 38, 51, 76, 102, 127 and 140 mm, arranged linearly from smallest to largest mesh. Half-standard gangs of gillnets, with 20 m of each mesh size and total length of 120 m, were used to sample fish during the 2004 survey.

In 2004, a total of 26 gillnets was set from June 2 to August 26 2004. An attempt was made to duplicate previous gillnet sets from the 1983 and 1995 surveys in terms of location, depth of set and time of year in order to allow comparison of catches, although additional nets were set in the upper Saskatchewan Landing reaches of the reservoir and no nets were set in the Qu'Appelle arm. All fish captured were enumerated. Lengths and weights of the majority of gamefish were taken. Rough fish were weighed in mass for each mesh size of gill net. A sub-sample of gamefish was examined for stomach contents.

Table 1a. Morphometric features of six regions of Lake Diefenbaker, 1967 - 1969 (from Royer 1972).

	Headwater Region	Sask Landing	Herbert Ferry	Riverhurst Ferry	Qu'Appelle Arm	Gardiner Dam
Area (%)	14	13	20	21	10	22
Maximum depth (m)	19.2	21.3	29.3	44.2	32.6	59.4
Average depth (m)[a]	...	14.6	15.8	25.6	15.8	30.5

[a] Depths were based largely on landscape contours (J. Merkowsky pers comm) since field-work was done in 1967 - 1969.

Table 1b. Morphometric features of nine regions of Lake Diefenbaker, 1985 (from SCSMA 1986).

	Head waters	Sask Landing	Beaver Flats	Snakebite Creek	Riverhurst Ferry	Hitchcock Coulee	Qu'Appelle Arm	Gardiner Dam	Coteau Bay
Area (km2)	64.0	35.4	52.4	81.1	58.7	51.9	65.9	69.7	2.6
(%)	(12.7)	(7.4)	(10.9)	(17.0)	(12.3)	(10.8)	(14.6)	(13.8)	(0.5)
Max. Depth (m)	6	22	27	38	44	50	52	57	25
Depth Strata (%)									
0 – 5m	? 80	12	11	11	6	7	13	9	23
5 – 10m	? 20	12	8	6	4	6	9	6	30
10 – 15m	0	36	13	9	5	5	14	14	23
15 – 20m	0	38	15	9	9	6	13	9	21
20 – 25m	0	2	30	10	10	5	11	4	3
25 – 30m	0	0	21	14	8	6	15	5	1
30 – 35m	0	0	0	25	9	6	6	5	0
35m +	0	0	0	17	48	60	19	47	0

In recent years, only small walleye and sauger were reportedly being caught around Saskatchewan Landing. There was some concern about the biological status of both species, since these two species are known to hybridize in nature. Further concerns related to potential impacts on 'pure' walleye, particularly since the major provincial spawn camp occurs on Lake Diefenbaker. Therefore, a major component of the 2004 survey was a determination of the degree of hybridization of walleye and sauger (saug-eye).

Samples for genetic analysis were collected from walleye, sauger and potential hybrid specimens during the netting program. Specimens were weighed, measured, and assigned to species based on overall impression of five visual characteristics: scaling of cheek, dorsal fin spot, body colouration, tail spot and number and length of pyloric caeca. Field staff observed intermediate characteristics during examinations, but recorded specimens as either walleye or sauger. Tissue samples of cheek muscle and liver were excised and cleaned in the field, and stored separately, either dry or in distilled water in 1.5 ml micro-centrifuge tubes, chilled on ice until frozen and then shipped for genetic analysis to Dr. Neil Billington (Troy University, Alabama). Saggital otoliths from the same specimens were collected, dried in envelopes, and sent with the tissue samples for ageing. Details on methods of the electrophoretic methods to determine degree of hybridization are given in Billington et al (2005).

Angler Survey

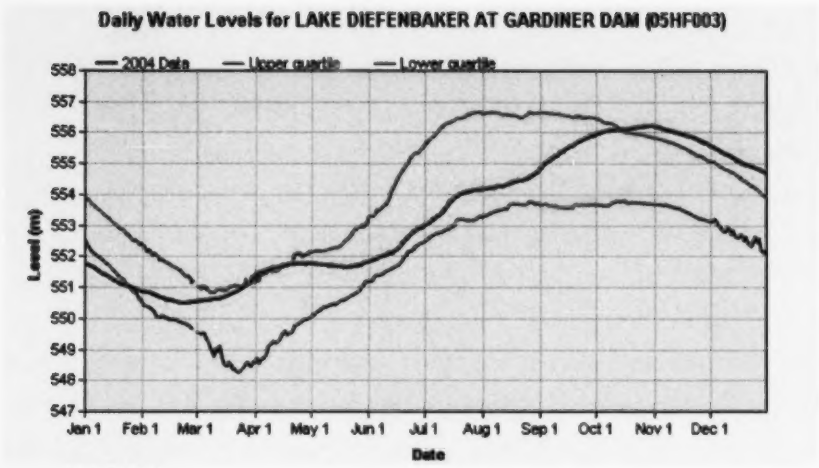
A creel survey was carried out from May 21 until August 15 2004 on Lake Diefenbaker to obtain information on the sport fishery. The survey was carried out by interviewing anglers while they were actively fishing at the various access points to Lake Diefenbaker. The majority of surveys were conducted from shore. The survey information focused on the number of anglers, time spent fishing, the catch and the overall perception of the fish resources in the lake. Two creel surveyors worked on the project.

On a designated survey day, the creel clerks would travel between three to five access points and conduct interviews. Although time spent at the various locations was not consistent, the locations were visited at various times of days to sub-sample the entire angler-day. Attempts were made to count boat trailers in the parking lots as well as note any anglers that were missed. Due to the large size of Lake Diefenbaker, and the numerous access points, complete angler counts were not possible. No attempt was made to determine total angling pressure or harvest. Days that the survey was carried out is given in Appendix 2. An example of the survey form is given in Appendix 3. The last series of questions was only asked of a subsample of anglers. Additional questions regarding numbers of days spent fishing on Lake Diefenbaker in 2003 was also asked of some anglers. A subsample of fish taken by anglers was measured as to fork length.

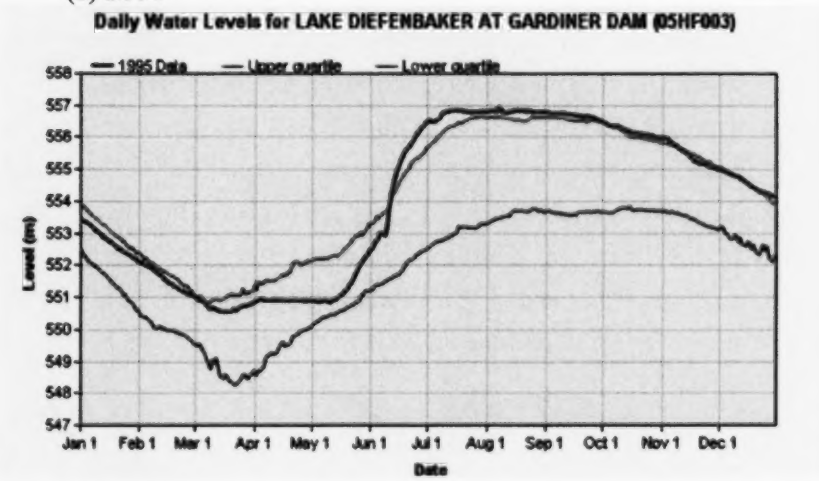
RESULTS

Physical and Chemical Parameters

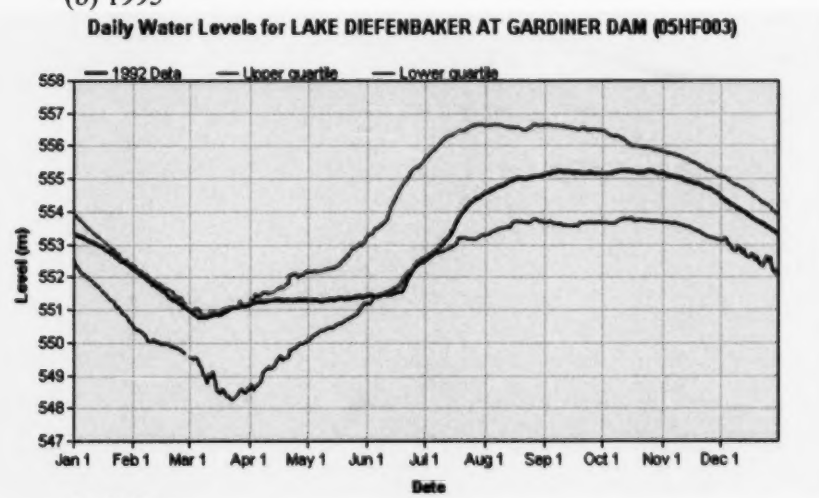
Graphs of water level data for 2004 and previous survey years were obtained from the Water Survey of Canada website for Lake Diefenbaker at Gardiner Dam (Station 05HF003). As indicated in Fig. 2a, water levels in 2004 were relatively 'intermediate' as compared to earlier survey years. As shown in Fig. 2b, water levels in 1995 rose rapidly by six meters, beginning in mid-May. Except for the 1995 study year, the water levels in other survey years remained within a 4 m range from May to August. The wide variation in water level, with minimum levels occurring in winter and spring, can have an impact to spring spawning fish species because potential spawning grounds may be high and dry.



(a) 2004



(b) 1995

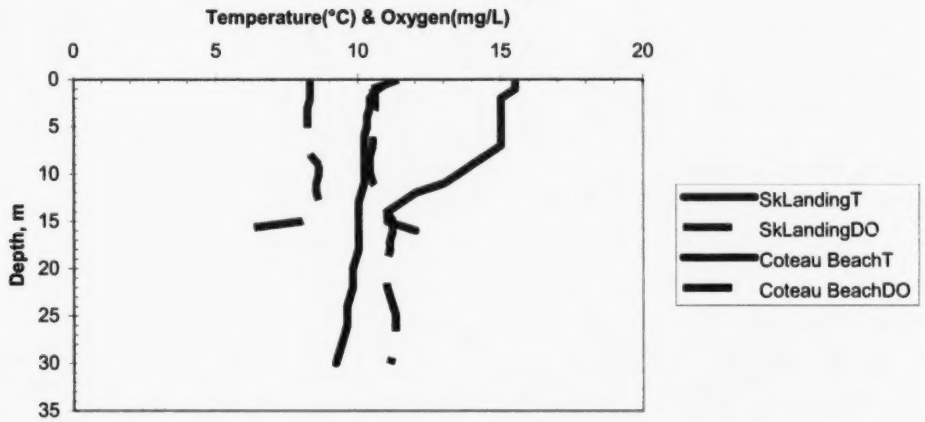


(c) 1992

Figure 2. Water levels during 2004, 1995 and 1992. Data from Water Survey of Canada.

Surface water chemistry and temperature – oxygen profiles for several locations and dates are given in Appendix 4. Surface water temperature varied from 11.2°C on June 22 2004 at Coteau Beach subdivision to a high of 18.2°C on August 11 at Douglas Park. Distinct thermocline development (drop of at least 1°C per meter depth) was not observed in 2004. Temperatures gradually dropped with increasing depths, and waters below 30 meters were generally 10°C or cooler. Table 2 provides data on water chemistry in several areas of the lake for 1995-2004, and 1978 – 1985.

Variations in temperatures measured at selected sites within Lake Diefenbaker show some general trends. The Saskatchewan Landing area warms up earlier than most areas due to the inflowing warm river. Coteau Bay in the extreme lower end is isolated and protected from wind action. Temperatures there tend to warm up early. Snakebite Bay and the area adjacent to Coteau Beach Subdivision are both located in the open lake. Temperatures at these two sites had not reached 15°C by late June although Snakebite Bay was 2°C warmer due to its proximity to river flows. Most open lake areas such as Riverhurst, Elbow and Gardiner show similar temperatures in July and August, with surface temperatures below 20°C, well mixed to about 15 m depth level, and then gradually dropping to 10-12°C in waters below 30 m. The graph below illustrates the difference in water temperatures and dissolved oxygen concentrations at sites in the upper reaches (Saskatchewan Landing) and the lower area (Coteau Beach Subdivision). Parameters at both sites were taken on June 22 2004 in the open lake.



As indicated, temperatures at Saskatchewan Landing were over 15°C down to the 10 meter depth, whereas at Coteau Beach temperatures were just barely over 10°C. Waters at Coteau Beach Subdivision tended to be well-mixed while temperature and oxygen at the upper station showed a weak stratification.

Seasonal temperature and oxygen readings are illustrated in the graph below. All parameters were measured in the open water within the main lake, although the station locations varied: June measurements were taken at Coteau Beach Subdivision, July at Riverhurst, and August midway between Elbow and Birsay.

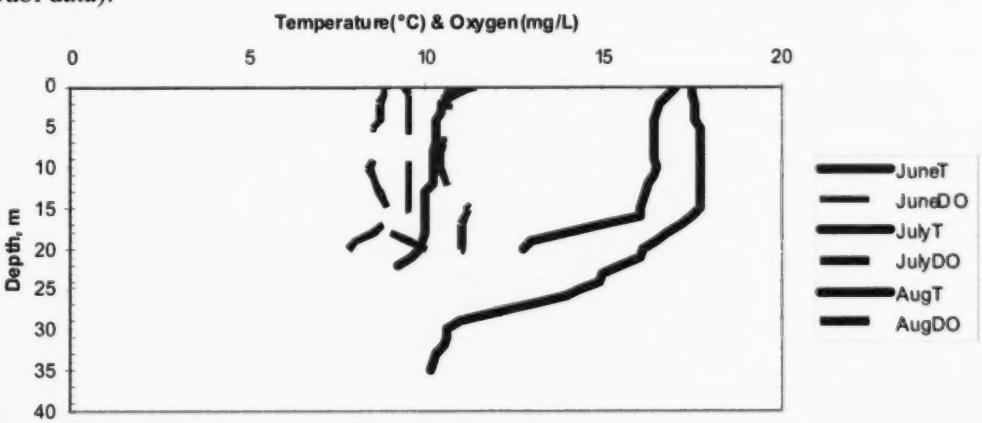
Table 2. Water chemistry in several areas, for 1995 - 2004 (3 surveys) and 1978 - 1985 (SEPS/EC 1988), Lake Diefenbaker.

Parameter	Period	Upriver[a] (Red River, AB, R1)	Upriver (SSR, AB, R2)	Upper (Sask Landing, 2)	Transition (Herbert Ferry, 3)	Lower (Riverhurst, 4)	Lower (Douglas Park, 5)	Downriver (Danielson Park, 6	(Outlook, R6)
PH	1995-2004	-	-	7.4 - 8.7[c]	8.1 - 8.7	7.6 - 8.8	8.3	8.3 - 8.6	-
	1978-1985	7.4 - 8.4	7.5 - 9.0	7.7 - 8.5	8.0 - 8.5	7.8 - 8.4	7.6 - 8.5	7.7 - 8.4	7.3 - 8.5
Secchi depth[b] (m)	1995-2004	-	-	0.03 - 0.8[c]	-	2.0	-	-	-
	1978-1985	-	-	0.72	2.85	4.15	3.30	3.53	-
Specific Conductivity (uS/cm)	1995-2004	-	-	355 - 496	379 - 432	350 - 441	395	395 - 427	-
	1978-1985	323 - 916	258 - 594	314 - 585	397 - 453	387 - 479	360 - 450	368 - 480	280 - 500
Total Alkalinity (mg/L)	1978-1985	40 - 417	87 - 227	114 - 216	132 - 189	142 - 172	146 - 164	142 - 164	124 - 176

[a] Zones are upriver, in the upper, transition, and lower areas, and downriver of Lake Diefenbaker, respectively. These zones are based on water chemistry, temperature, and turbidity data. Stations R1 to R6 are river sites (including South Saskatchewan River, R2) and Stations 2 to 6 are lake sites (SEPS/EC 1988).

[b] Secchi depth is the summer average for 1978-85 (SEPS/EC 1988).

[c] Very low pH and Secchi depth occurred in June of 1995 after flooding (Ron Jensen in Branch files, unpubl data).



The figure above indicates that oxygen remains well mixed throughout the water column at all three stations, whereas temperatures showed some stratification during July and August.

Oxygen levels measured during the open water season were constantly near saturation, even those measurements recorded near the bottom of the water column. This is in contrast to measurements taken from 1967 to 1969 shortly after the reservoir filled (Royer 1972). In those years, the oxygen deficiencies were attributed to decomposition of flooded terrestrial vegetation.

Figure 3 shows a cross-section of Lake Diefenbaker with mid-summer depths of water temperatures measured in August 1969 (adapted from Royer 1972). Figure 4 is a cross-section of Lake Diefenbaker that indicates the proportion of area within each depth zone. The two layers correspond to areas that would be above and below 18°C in mid-summer.

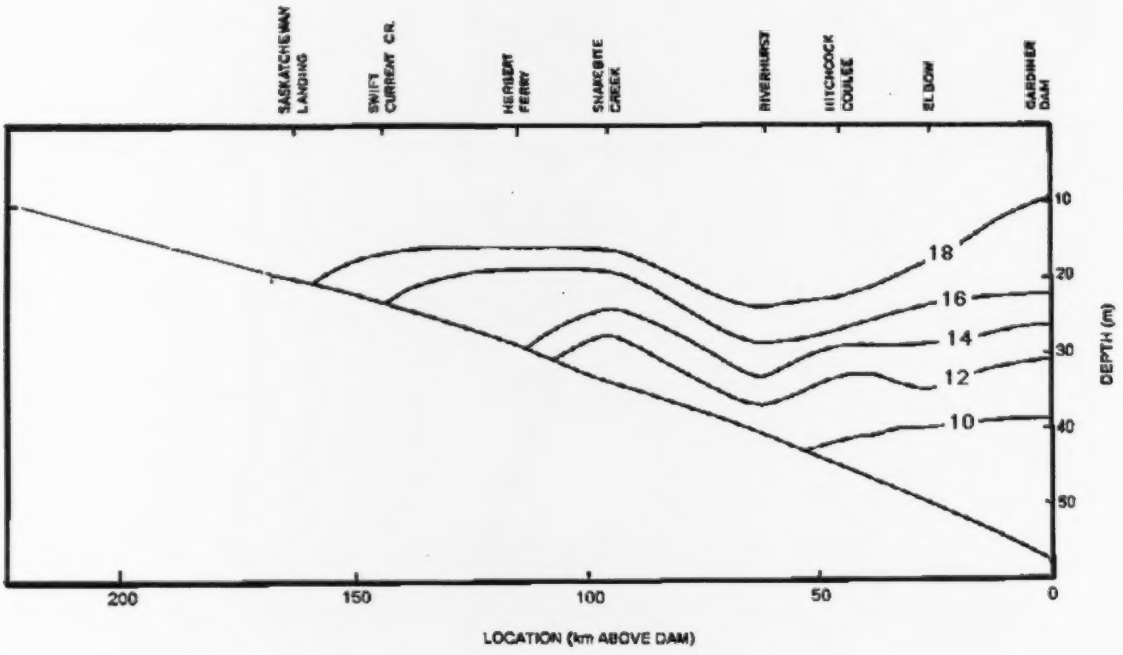


Fig. 3. Cross-section of Lake Diefenbaker showing mid-summer depths of water temperatures in August 1969 (from Royer 1972).

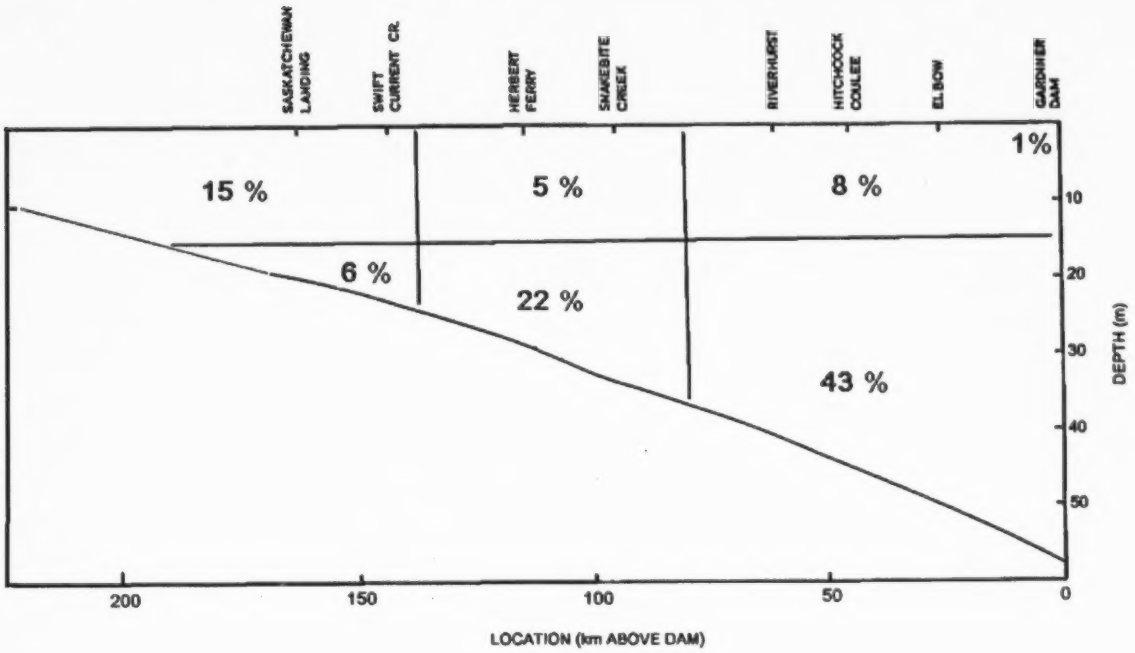


Fig. 4. Cross-section of Lake Diefenbaker showing the proportion of area in each zone and depth (as percent of lake area). Nine regions were combined into 4 zones (Coteau Bay is less that 1 %) and 2 layers (defined by the approximate mid-summer depth of 18°C, from Royer 1972).

Surface pH varied from 8.1 to 8.8, similar to values measured in the 1960s (Appendix 4). No measurements were done in the bottom waters.

Conductivity measurements varied from approximately 350 to 500 µS/cm, with most values fairly consistent at 450 µS/cm. The relative freshness of the reservoir is likely due to the spring inflows from mountain headwaters.

Transparency measurements were taken only in early June during the 2004 study. As noted in previous surveys, transparency in the Saskatchewan Landing end is lower, due to the turbid condition of the inflowing South Saskatchewan River. In early June, water clarity in this area was only 0.7 m whereas, at Coteau Bay measurements of 2.1 m were taken.

Fish Status

Species Composition

Numbers and species of fish captured in Lake Diefenbaker in 2004 standard gang gillnets are given in Appendix 5. Locations of gillnet sets are illustrated in Fig. 5. Lake Diefenbaker has a wide variety of large-bodied fish species present, similar to results reported in earlier surveys:

Common Name	Scientific Name	Collected in					
		1967-1969*	1973+	1983	1992	1995	2004
Lake sturgeon	*Acipenser fulvescens*	X				X	X
Lake whitefish	*Coregonus clupeaformis*	X	X	X	X	X	X
Cisco	*Coregonus artedi*			X	X	X	X
Rainbow trout	*Oncorhynchus mykiss*	X				X	X
Lake trout	*Salvelinus namaycush*	X				X	X
Atlantic salmon	*Salmo salar*					X	
Goldeye	*Hiodon alosoides*	X	X	X	X	X	X
Mooneye	*Hiodon tergisus*	X				X	X
Northern pike	*Esox lucius*	X	X	X	X	X	X
Longnose sucker	*Catostomus catostomus*	X	X	X	X	X	X
White sucker	*Catostomus commersoni*	X	X	X	X	X	X
Quillback	*Carpiodes cyprinus*	X		X	X	X	X
Silver redhorse	*Moxostoma anisurum*				X	X	X
Shorthead redhorse	*Moxostoma macrolepidotum*	X	X	X	X	X	X
Burbot	*Lota lota*	X	X	X	X	X	X
Yellow perch	*Perca flavescens*	X	X	X	X	X	X
Walleye	*Sander vitreus*	X	X	X	X	X	X
Sauger	*Sander canadensis*	X	X	X	X	X	X

* Royer (1972)
+Smith (1974)

Forage fish are not included in the table above, since survey methods in 2004 did not target small-bodied species.

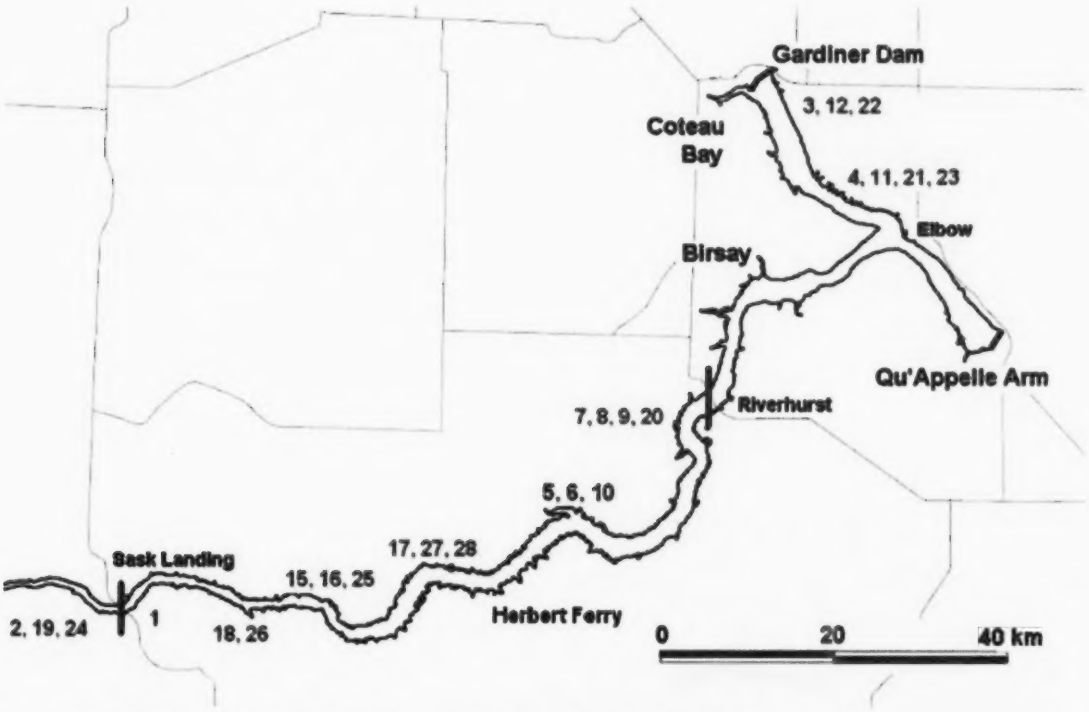
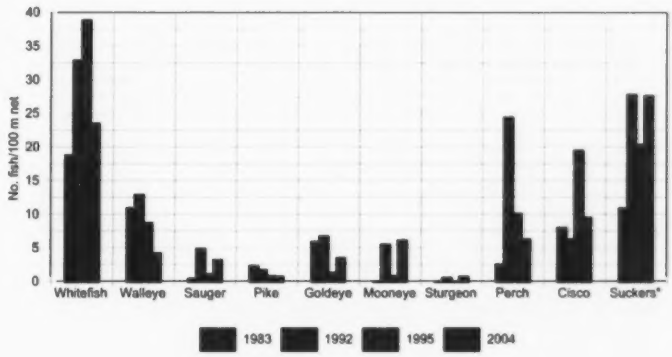


Fig. 5. Locations of gillnet sets in Lake Diefenbaker during 2004.

Total catch comparison by species per 100 m of standard gang gillnet and percent of catch is given for 1983, 1992, 1995 and 2004 in the table below:

	No. fish/100 m net				Percent of catch			
Species	**1983**	**1992**	**1995**	**2004**	**1983**	**1992**	**1995**	**2004**
Lake whitefish	18.8	32.9	38.9	23.5	26	27	38	28
Walleye	10.9	12.9	8.7	4.2	15	10	8	5
Sauger	0.4	4.8	1.1	3.2	1	4	1	4
Northern pike	2.3	1.7	0.8	0.7	3	1	1	1
Burbot	0.6	0	0	0.1	1	0	0	0
Lake trout	0	0	0.3	<0.5	0	0	0	0
Goldeye	5.9	6.7	1.3	3.5	8	5	1	4
Mooneye	0	5.5	0.8	6.1	0	4	1	7
Rainbow trout	0	0	0	0.2	0	0	0	0
Lake sturgeon	0	0.5	0	0.7	0	0	0	1
Atlantic salmon	0	0	<0.5	0	0	0	0	0
Yellow perch	2.5	24.4	10.1	6.3	3	20	10	8
Cisco	8.0	6.3	19.5	9.5	11	15	19	11
Suckers*	10.9	27.8	20.3	27.6	11	23	20	32
Total	60.4	123.5	102.5	85.7	100	100	100	100

*Five species of suckers occur in Lake Diefenbaker: white sucker, longnose sucker, quillback, shorthead redhorse and silver redhorse. White sucker is the most common species present, and usually represents over 50% of the total number of suckers. The various species of sucker are not delineated in either the table or in the adjacent graph, but are enumerated in Appendix 5. Species captured infrequently are omitted from the graph.



Water levels vary substantially in Lake Diefenbaker and presumably influence fish behaviour. Thus, comparisons of test net catches, even when similar dates and locations are used, may not be conclusive and interpretation of trends in catches must be made cautiously. It is apparent from the table and graph above that gamefish populations continue to be dominated by percids (walleye, sauger and perch), and by whitefish. Northern pike, burbot, rainbow and lake trout continue to be captured only occasionally. Suckers, represented by five species, remain abundant in the gillnet catches.

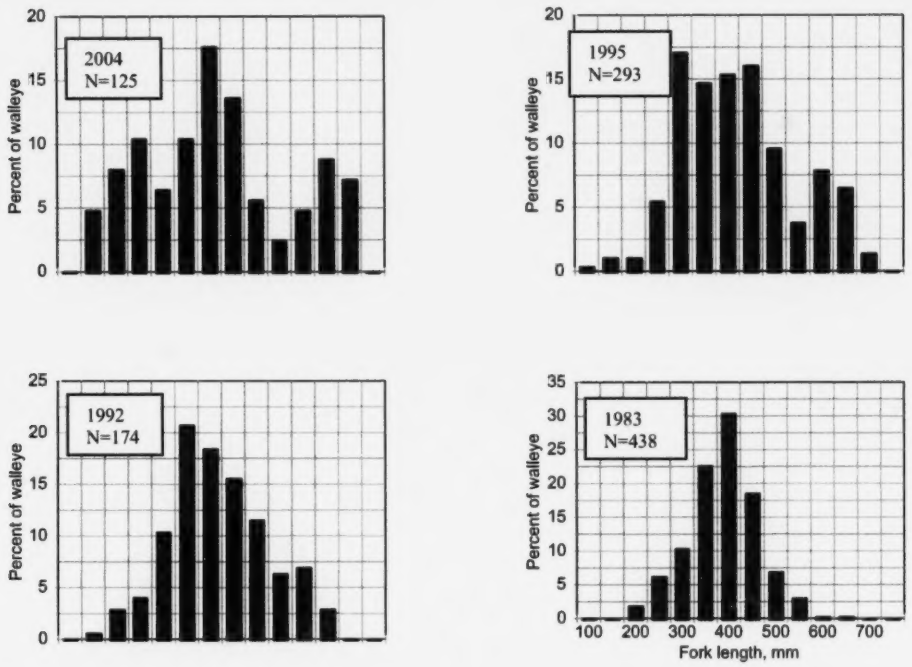
Walleye

A total of 126 walleye were captured in the 2004 gillnets. These fish ranged in size from 151 mm to 744 mm in fork length, and weighed from 30 to 6200 g. A comparison of lengths and weights of walleye taken in the various surveys is given:

Year		Range	Average
2004	FL, mm	151 - 744	435
	Wt, g	30 - 6200	1274
1995	FL, mm	335 – 746	485
	Wt, g	45 - 6300	1332
1992	FL, mm	188 - 680	438
	Wt, g	40 - 3700	1126
1983	FL, mm	224 - 682	410
	Wt, g	100 - 3100	831

As indicated in the table above, average size of walleye was similar during all the surveys with the exception of 1983. In this particular year, the walleye captured tended to be smaller.

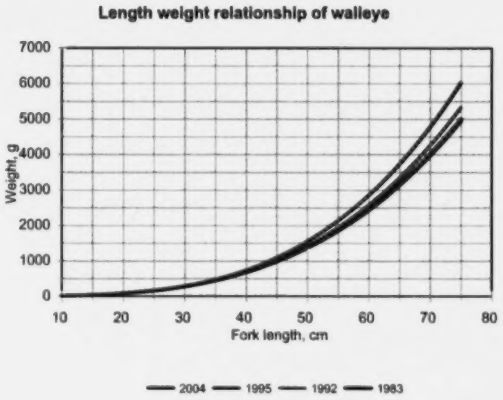
Length-frequency analysis of the walleye captured in the standard gang gillnets for several surveys is illustrated in the graphs below:



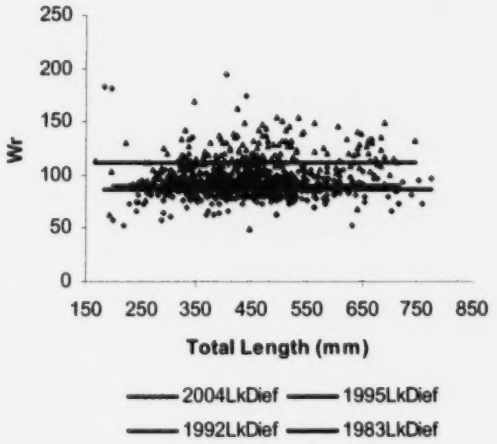
As indicated in the graph, walleye captured in the 2004 survey nets were represented by numerous length classes, suggesting a stable, healthy population. To determine whether the walleye captured

in the Saskatchewan Landing area were significantly smaller than walleye caught in other areas, a two tailed t-Test was done between walleye caught in the upper and lower reaches of the lake. Results suggested that there was no significant difference in fork lengths from walleye captured above and below Riverhurst Ferry.

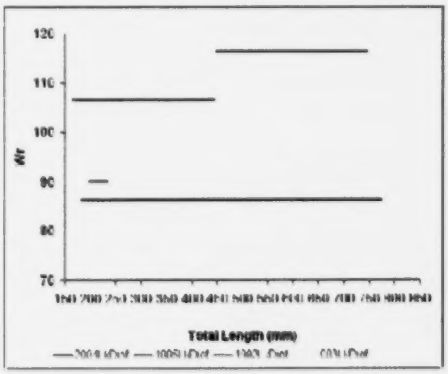
A length-weight regression was done to compare growth of walleye taken in the gillnets from various survey years, and results are illustrated in the adjacent graph. As indicated in the graph, there has been little change in the growth rates of walleye from 1983 to the 2004 survey.



Calculation of relative weight (W_r) index can be used to assess the overall body condition or robustness of fish. This calculation, developed by Wege and Anderson (1978) is the ratio of a fish's weight to the standard weight of a fish of the same length, and is expressed as a percentage. The advantage of using this ratio over the more traditional condition factor is that W_r is not biased by the length of the fish. Relative weights of walleye captured during the various years of survey are presented in the adjacent graph. The mean relative weights of walleye for the four survey years are represented by the solid bars. Walleye captured during the 2004, 1992 and 1983 surveys had very similar mean relative weights; whereas walleye taken during the 1995 survey had a heavier relative weight.

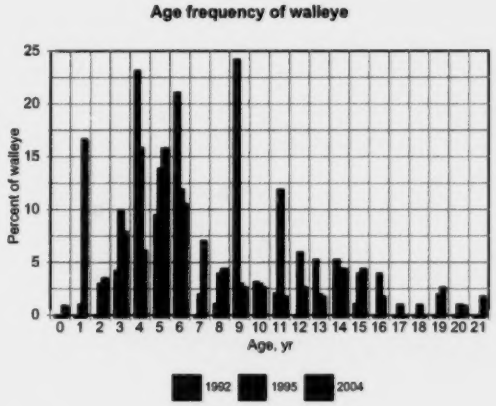


It is recommended that relative weights be examined among length-classes across seasons, because this calculation can be more sensitive to changes in prey availability (Porath and Peters 1997). The data from 1995 walleye was broken down into two length categories, 150 to 450 mm and 450 mm to 700+ mm, based on significant differences in relative weight between them. While both these length groups had a

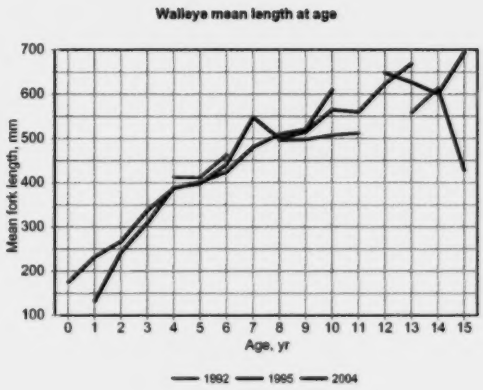


larger relative weight as compared to walleye from the other three studies, the longer walleye had a larger relative weight. This is illustrated in the adjacent graph. No other significant differences were seen between lengths in other years.

A sub-sample of the walleye captured in the 2004 gillnets was aged, using the saggital otoliths. Age frequency distribution is given in the adjacent graph. Ageing results from walleye taken in the 1992 and 1995 surveys are given for comparison. Walleye taken in the 2004 gillnets ranged in age from 0 to 21 years, with the majority falling within the 3 to 7 year age classes. A wider variety of age classes was represented in the present survey than was determined from the 1992 survey.



Average length at age for walleye from Lake Diefenbaker, illustrated in the adjacent graph, appears to have changed little from previous surveys carried out in 1992 and 1995. Results must be interpreted with caution as ages were determined by different individuals for the various survey years. Inconsistencies with growth of walleye over 10 years in age are likely a result of few fish in the older age classes. For this reason, fish over 15 years of age were not included in the results.



The majority of walleye were examined for sexual maturity. In 2004, it appeared that female walleye were beginning to mature at approximately 400 mm in fork length, roughly corresponding to the 5 year age class. By 500 mm, the majority of female walleye appeared mature.

A sub-sample of 52 walleye was examined for food habits. A total of 44.2% of the walleye contained fish remains, with over half the fish identified as either whitefish or sucker. Crayfish and insects made up a small proportion of the food items identified. Almost 50% of the walleye examined had empty stomachs.

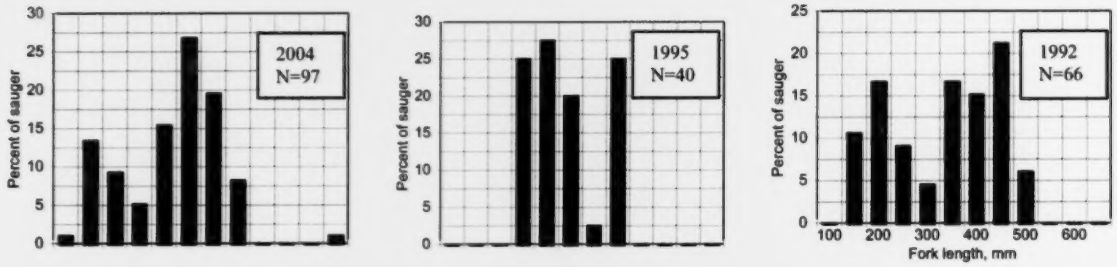
Sauger

A total of 97 sauger were captured in the 2004 gillnets. These fish ranged in size from 108 mm to 662 mm, and weighed from 46 to 3200 g. A comparison of lengths and weights of sauger taken in the various years is given:

Year		Range	Average
2004	FL, mm	108 - 662	339
	Wt, g	46 – 3200	451
1995	FL, mm	261 - 495	363
	Wt, g	125 - 1275	495
1992	FL, mm	185 - 525	354
	Wt, g	40 - 1500	535

Little variation in average size of sauger taken in the various survey years was apparent with the exception of a 3200 g fish taken during the 2004 study. Species identification was based on field examination: ultimately this specimen was determined to be a walleye based on genetic testing.

Length-frequency analysis of the sauger captured in the standard gang gillnets for several surveys is illustrated in the graphs below:

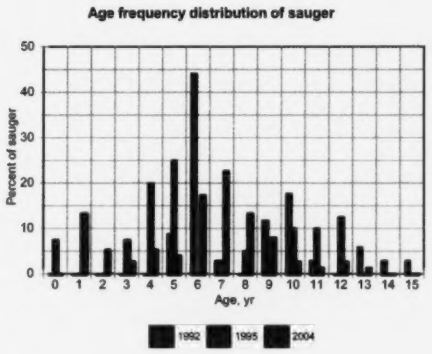


As indicated in the graphs above, numerous length classes of sauger were captured in the 2004 test nets, suggesting a stable, healthy population. Many more length classes were represented in the 2004 nets as compared to the 1995 nets. Inadequate numbers of sauger were taken in the 1983 test nets, so these fish are not included in the length-frequency graphs. To determine whether the sauger captured in the Saskatchewan Landing area were significantly smaller than sauger caught in other areas, a two tailed t-Test was done between sauger caught in the upper and lower reaches of the reservoir. Results suggested that there was no significant difference in fork lengths from sauger caught above and below Riverhurst Ferry.

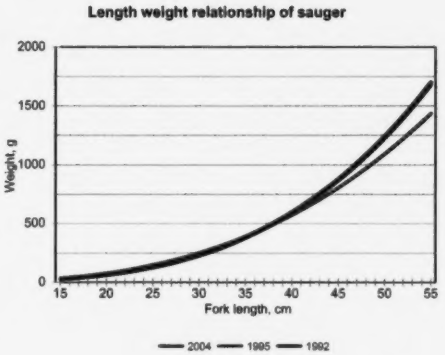
A length-weight regression was calculated to compare growth of sauger during three different years of survey. Although results suggest that growth of larger sauger is slower during the 2004

survey, caution must be taken in the interpretation as only one sauger larger than 50 cm was captured during that year.

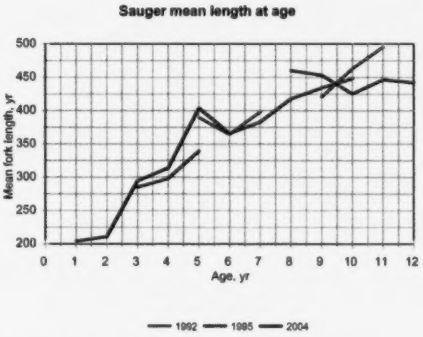
A sub-sample of the sauger taken in the 2004 gillnets was aged, using the saggital otoliths. Age frequency distribution is given in the adjacent graph for sauger caught in 2004, 1995 and 1993. Sauger taken in the 2004 nets ranged in age from 1 to 13 years of age, with the majority of fish aged between 6 to 9 years. Numerous age classes were represented in the present population, suggesting a stable, healthy population. The capture of several one-year-old sauger is indicative of successful natural reproduction in recent years.



Average length at age for sauger taken in 2004 is illustrated in the adjacent graph. Since some age classes in 1992 and 1995 are missing, it is difficult to compare growth between the various survey years. From the data presented in the graph, there does not appear to be much variation in length of fish at ages between surveys. Few fish 8 to 9 years were caught in 1995 as compared to fish between 10 to 12 years of age, so average length for the former age classes must be interpreted with caution.



The majority of sauger were examined to determine size when sexual maturity was reached. In 2004, female sauger appeared to begin maturing at approximately 315 mm, roughly corresponding to the 4 year class. By 350 mm, all females that were examined appeared to be mature.



A sub-sample of 21 sauger was examined for food habits. Unidentified fish remains were encountered in over 35% of the stomachs, with snails and insects found in over 20% of the fish. Approximately 40% of the sauger examined had empty stomachs.

Hybrids

A total of 191 walleye and sauger specimens were analyzed electrophoretically and aged. There were 41 confirmed hybrids, accounting for 22% of the specimens analyzed. This proportion is believed to be representative of the entire reservoir, as samples were collected from June to August, from areas upriver of Saskatchewan Landing to the lower end near Gardiner Dam, over a range of fish sizes, and comprising a high proportion of all walleye/sauger collected.

Genetically, 96 fish identified as 'walleye' visually in the field were walleye, 54 fish identified as 'sauger' were sauger, and 41 fish were hybrids. Of these 41 hybrids, 28 fish (68%) had at least one characteristic of the 'other' species or a question mark in field records. This comprised 13 individuals classed visually as walleye and 15 classed as sauger.

Hybrids represented 22% of the sauger-walleye caught in the riverine zone (headwaters and Saskatchewan Landing – H-SkL), 24% in the transition zone (Beaver Flats and Snakebite Creek – B-SCk) but only 14% in the downstream, open-lake areas from Riverhurst to Gardiner Dam (R-GDam). Results as determined by electrophoresis, are given in the table below:

Zone	Number Of nets	Number of specimens	Number of			
			Walleye	Sauger	Hybrids	% Hybrids
H-SkL	6	107	51	33	23	21.5
B-SCk	7	55	27	15	13	23.6
R-GDam	6	29	19	6	4	13.8

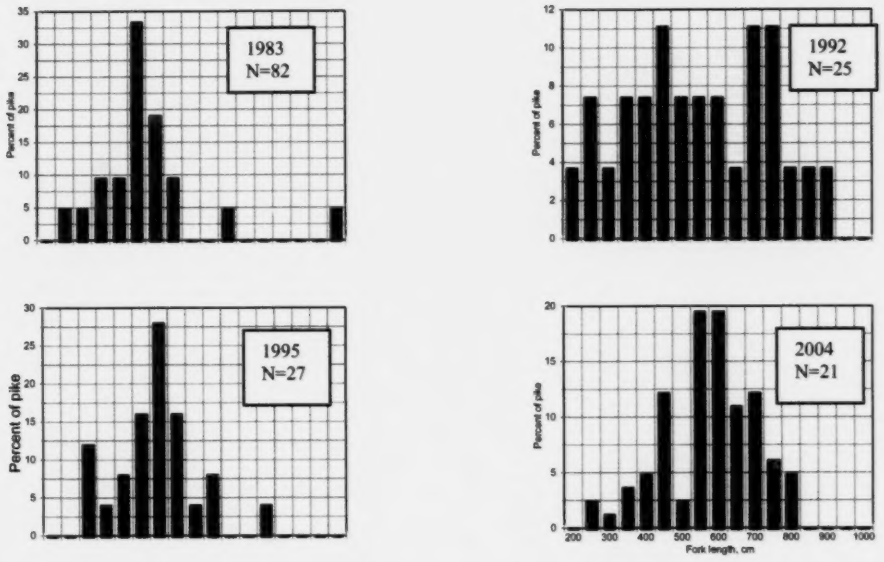
Genetically, pure walleye specimens ranged in fork length from 151 to 744 mm, sauger from 171 to 477 mm, and hybrids from 165 to 737 mm. There was substantial overlap in size composition, although no pure sauger was over 500 mm in fork length.

Northern Pike

Only 21 pike were captured in the 2004 gillnets, which is similar to numbers taken in 1992 and 1995. In the present survey, pike ranged in size from 262 mm to 1003 mm in fork length and weighed from 144 g to 7800 g. A comparison of average lengths and weights of pike captured during the various years of survey is given:

Year		Range	Average
2004	FL, mm	262 – 1003	499
	Wt, g	144 – 7800	1247
1995	FL, mm	240 – 900	569
	Wt, g	85 – 6900	2220
1992	FL, mm	322 - 801	514
	Wt, g	360 – 4500	1269
1983	FL, mm	277 – 830	596
	Wt, g	150 – 4750	1765

Although average fork length is similar for the various years, average weight has shown more fluctuation and is likely affected by small sample size. Length-frequency analysis of the pike captured in the standard gang gillnets is illustrated in the graph below.



As suggested in the length-frequency graph above, pike taken in the 2004 survey nets tended to be represented by smaller fish than caught in previous surveys. Despite the relatively small sample size, numerous length classes were present in the 2004 catch. The capture of small pike suggests that some natural reproduction is occurring. Due to the small sample size, it was not feasible to carry out a length weight regression or calculate relative weights for this species.

No ageing material was collected from pike for analysis. The majority of pike were examined to assess state of sexual maturity. Female pike began to mature at approximately 250 mm, and all were mature by 490 mm.

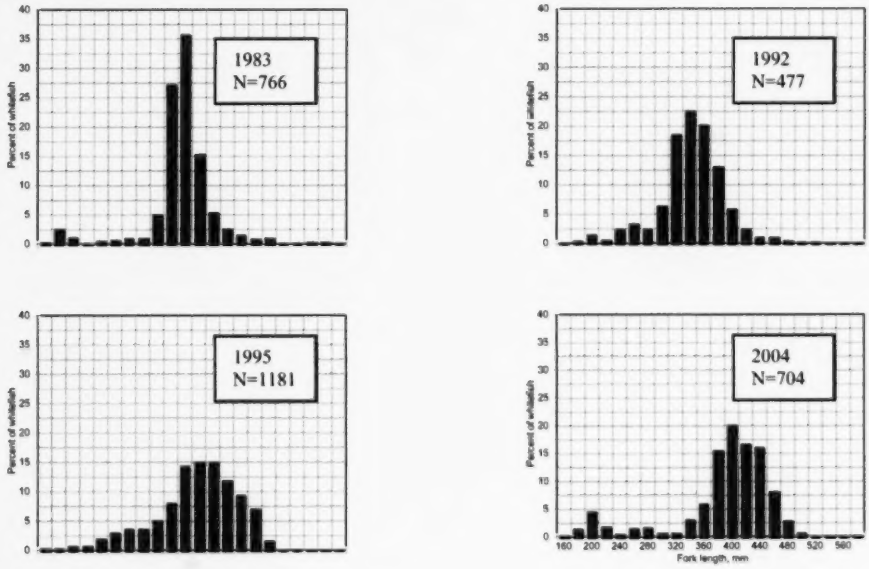
Eight pike were examined for food habits, and of these, seven were empty. The remaining pike had perch remains in its stomach.

Lake Whitefish

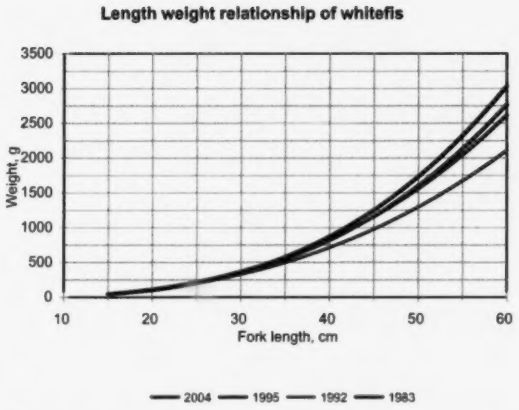
A total of 706 whitefish were captured in the standard gang gillnets during the 2004 survey. Whitefish was the most abundant species captured in the nets. A comparison of lengths and weights of whitefish taken during the various survey years is given:

Year		Range	Average
2004	FL, mm	170 - 570	363
	Wt, g	50 - 2500	643
1995	FL, mm	192 - 520	351
	Wt, g	85 - 1800	599
1992	FL, mm	169 - 497	385
	Wt, g	50 - 1950	677
1983	FL, mm	175 - 512	399
	Wt, g	75 - 1910	934

Average length of whitefish has remained relatively constant over the various years of survey, whereas weight has shown some fluctuations. In the 2004 survey, whitefish showed the largest range in weight. Length-frequency analysis of the whitefish captured in the various survey years is illustrated in the graphs below:



In 2004, there was a wide range in length classes. However, as indicated in the adjacent graph, the major proportion of whitefish taken in the 2004 gillnets were between 320 to 400 mm.



A length-weight regression was done to compare growth of whitefish captured during the various years of survey. Little change has occurred in growth rates of whitefish during the various survey years, with the exception of 1992. During this year, the whitefish appeared to show slower growth. However, few fish greater than 50 cm were taken so differences in growth rates must be interpreted with caution.

No ageing material was collected from whitefish. A total of four whitefish were examined for food habits. Three contained *Sphaeriids* (fingernail clams) and the remaining whitefish had vegetation in its stomach.

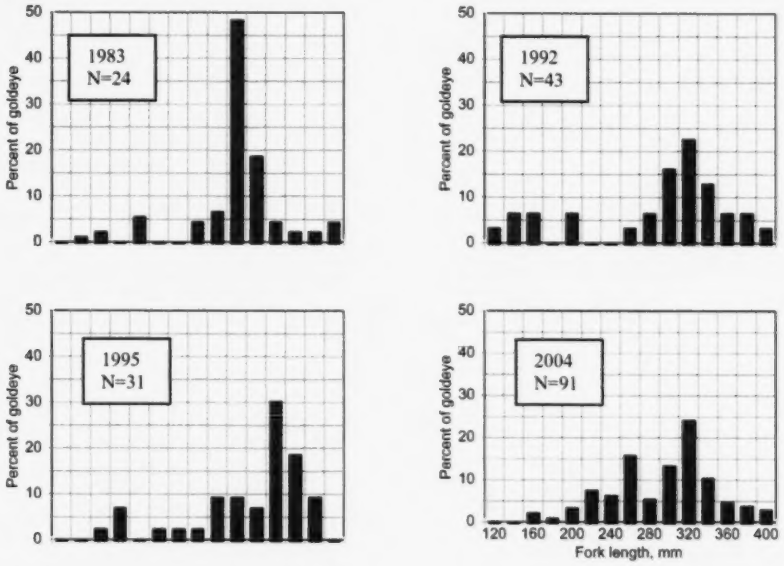
Goldeye

A total of 106 goldeye were taken in the survey nets during the 2004 study. Although more goldeye were collected during the present survey than since 1992, percent composition in the total catch remains relatively low. This species varied in fork length from 145 to 414 mm and from 30 to 800 g. A comparison of lengths and weights of goldeye taken during the various surveys is given:

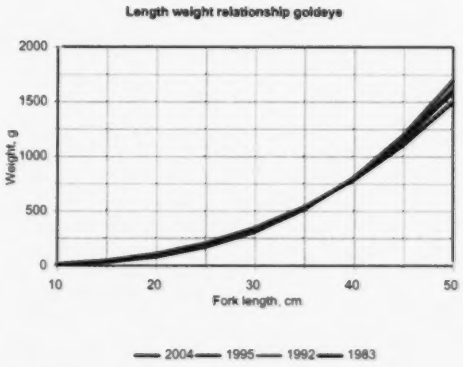
Year		Range	Average
2004	FL, mm	145 - 414	310
	Wt, g	30 - 800	390
1995	FL, mm	135 - 400	300
	Wt, g	15 - 800	365
1992	FL, mm	174 - 398	325
	Wt, g	50 - 850	455
1983	FL, mm	170 - 410	300
	Wt, g	65 - 850	390

As indicated in the above table, average size of goldeye was similar during all surveys.

Length-frequency analysis of the goldeye captured in the standard gang surveys is illustrated in the graphs below:



As illustrated in the adjacent graph, a majority of the goldeye captured during the 2004 survey were between 300 and 340 mm. During all surveys, a good number of size classes were represented in the catches. Numerous goldeye fell within the shorter length classes, suggesting that successful natural reproduction is occurring.



A length-weight regression was done to compare growth of goldeye taken in the standard gang gillnets during the various survey years. As indicated in the graph, there has been little change in the growth rates of goldeye from 1983 to the present 2004 survey.

No stomach content analysis was done on goldeye, and no fish were examined for sexual maturity.

Yellow Perch

A total of 188 yellow perch were collected in the 2004 survey nets. Measurements from 76 perch were taken. Fork lengths of the perch analyzed ranged from 140 to 270 mm, and varied in weight from 50 to 400 g. The majority of perch fell within the 200 to 250 mm length class. However, perch that are shorter than 180 mm are typically not analyzed; therefore the above length analyses are not representative of the total catch of perch in the gillnets.

No ageing material was retained from perch. One perch was analyzed for food habits, and it contained crayfish remains in its stomach.

Lake Sturgeon

A total of 21 lake sturgeon were captured in the standard gang gillnets during the 2004 survey, which is an increase in numbers from earlier surveys. Lengths and weights were taken from 15 of these fish:

Number of sturgeon	FL, mm	Weight, g
1	30	160
6	280 - 294	130 - 210
6	334 - 375	210 - 310
2	820 - 855	4800 - 5400

All sturgeon were captured upstream from Riverhurst Ferry in nets that were set predominantly in water less than 10 meters deep. As evident in the table above, a variety of sizes of sturgeon was captured. The capture of small sturgeon suggests that reproduction is successfully occurring somewhere within the river system.

Rainbow Trout

A total of seven rainbow trout were captured in the 2004 survey nets, which is an increase from numbers of this species taken in earlier surveys. Distribution of lengths and weights of the rainbow trout caught in 2004 is given:

Number of rainbow trout	FL, mm	Weight, g
3	450 – 465	1060 – 1600
2	505 - 510	1580 - 1600
2	545 - 546	2300 - 2600

All rainbow trout were captured at or below Riverhurst Ferry. The majority of the trout were taken in nets set at Elbow. One fish was examined for stomach contents, and it had been feeding on crayfish.

Other Species

Several other species of gamefish were captured in the 2004 gillnets. One lake trout was taken in nets set off Coteau Beach Subdivision at a depth of 30 m. This fish measured 775 mm and weighed 7000 g.

One burbot was taken in a net set off Snakebite Bay. This fish was 665 mm in total length, and weighed 2200 g. Burbot is a species that tends not to be captured frequently in the standard gang gillnets.

A total of 184 mooneye were taken in the 2004 gillnets. Over 60% of these fish were captured in one net set in the riverine portion of the reservoir above Saskatchewan Landing. This species belongs to the same genus as goldeye, and the two can be difficult to differentiate. Mooneye tend to be of a smaller size. The majority of this species were not individually sampled.

A total of 284 cisco were captured in the 2004 gillnets. This species is in the same genus as whitefish, but tend to be smaller in size. Cisco were captured in the majority of nets set in Lake Diefenbaker in 2004, indicating it is common throughout the reservoir. This species was not analyzed as to individual lengths and weights.

Angler Survey Results

A total of 1161 anglers were interviewed from May 21 until August 15 2004 (Table 3). Of those, 130 were unlicensed anglers, under the age of sixteen years. The majority of anglers were contacted at Saskatchewan Landing Provincial Park, and the fewest at Herbert/Prairie Lake Park. Other popular sites were the Cangro fish farm (now Wild West Steelhead), Coteau Bay (including Danielson Provincial Park and Gardiner Dam), and the Riverhurst – Palliser Regional Park. Of those anglers interviewed, anglers fishing from shore slightly outnumbered anglers fishing from a boat, with shore anglers comprising 54% of those contacted (Table 3). However, the shore anglers were more easily contacted and are likely overrepresented as a group.

Average hours fished was determined from those anglers that had completed their fishing trip. Shore fishermen angled an average of 3.03 hours per day, whereas those using a boat fished an average of 3.75 hours per day. Only 28.9% of the anglers questioned indicated that they ice fished on Lake Diefenbaker. As indicated in Appendix 6, the majority of angling effort (approximately 80%) occurs on weekends and designated holidays.

Origin of anglers fishing at Lake Diefenbaker in 2004 is given in Table 4. Almost 30% of the anglers were from Saskatoon. Over 90% of the anglers interviewed were Saskatchewan residents. As indicated in Table 5, over 50% of the anglers came out to Lake Diefenbaker on a day trip. Over 30% of the anglers stayed at one of the many campgrounds located around the lake.

The Catch

Anglers interviewed caught a total of 1544 fish (Table 6), expending a total of 3450 angler-hours on the lake. Walleye (25%), rainbow trout (29 %) and goldeye (24%) were the most frequently caught species. Species composition of the angler's creel varied with locality of fishing. Those fishing from shore by the Wildwest Steelhead Fish Farm caught almost entirely rainbow trout. The majority of walleye and sauger were taken by anglers fishing in the Saskatchewan Landing area. The majority of goldeye were also caught at Saskatchewan Landing. No burbot or sturgeon was caught by any of the anglers who were interviewed during the creel census.

Table 3. Numbers of anglers contacted at various access points around Lake Diefenbaker from May 21 to August 15 2004.

	Boat Anglers		Shore Anglers		Total Anglers	
	No.	%	No.	%	No.	%
Cangro Fish Farm	0	0	175	15.1	175	15.1
Coteau Bay*	62	5.3	63	5.4	125	10.8
Danielson Provincial Park*	31	2.7	62	5.3	93	8.0
Elbow Harbour	49	4.2	7	0.6	56	4.8
Douglas Provincial Park*	0	0	16	1.4	16	1.4
Hitchcock Bay	45	3.9	18	1.6	63	5.4
Riverhurst/Palliser Park*	181	15.6	90	7.8	271	23.3
Herbert/Prairie Lk Park	4	0.3	7	0.6	11	0.9
Beaver Flats	2	0.2	8	0.7	10	0.9
Sask. Landing Provincial Park	161	13.9	180	15.5	341	29.4
Total	535	46.1	626	53.9	1161	

*Coteau Bay includes pumphouse bay near spawn camp.
*Danielson Provincial Park includes Gardiner Dam and Spillway.
*Douglas Provincial Park includes Qu'Appelle Dam and South Beach.
*Riverhurst/Palliser Park includes Rusty's Marina.

Table 4. Origin of anglers fishing at Lake Diefenbaker from May 21 to August 15 2004.

Angler Origin	No. of anglers	% of anglers
Local *	201	17.6
Saskatoon	324	28.3
Regina/Moose Jaw	219	19.2
Swift Current	154	13.5
Other Saskatchewan towns	197	17.2
Alberta	34	3.0
Manitoba	6	0.5
British Columbia	2	0.2
United States	3	0.3
Korea	3	0.3
Total Anglers	1143	100

*Local includes communities located less than 50 kilometres from Lake Diefenbaker.

Table 5. Numbers of anglers and where they stayed at Lake Diefenbaker during the summer of 2004.

	No.	Percent
Cabin owners	105	9.1
Campground	389	33.6
Day visit	627	54.1
Fish farm employee	16	1.4
Hotel	16	1.4
Houseboat	6	0.5
Total	1159	100

Table 6. Numbers of gamefish caught by anglers at various locations on Lake Diefenbaker, 2004.

	No. anglers	Total Angler-hr	Pike	Walleye	Rainbow Trout	Sauger	Goldeye	Other+	Total	Fish/ Angler-hr
Cangro Fish Farm	175	614.00	1	0	231	1	1	9	243	0.40
Coteau Bay*	122	486.75	22	66	103	0	13	32	236	0.49
Danielson Park*	93	325.50	19	5	17	2	4	13	60	0.18
Elbow	59	180.50	11	8	7	0	0	6	32	0.18
Douglas Park*	16	35.50	0	0	7	0	1	0	8	0.23
Hitchcock Bay	63	191.00	19	7	5	2	1	22	56	0.29
Riverhurst/Palliser*	271	684.10	26	84	60	10	37	48	265	0.39
Herbert/Prairie Lake Park	11	27.15	0	1	0	0	0	0	1	0.04
Beaver Flats	10	28.15	0	4	0	0	13	2	19	0.68
Saskatchewan Landing Park	341	876.60	12	216	12	46	297	41	624	0.71
Total	1161	3449.25	110	391	442	61	367	173	1544	0.45
Percent			7.1	25.3	28.6	4.0	23.8	11.2	100	

+ Other includes perch, whitefish, mooneye, saugeye and suckers.
* Coteau Bay includes pumphouse bay near spawn camp.
* Danielson Provincial Park includes Gardiner Dam and Spillway.
* Douglas Provincial Park includes Qu'Appelle Dam and South Beach.
* Riverhurst/Palliser includes Rusty's Marina.

Table 7. Numbers of gamefish caught and kept by anglers at Lake Diefenbaker, 2004.

Species	No. kept	No. Released	Total Caught	Percent Of catch	Percent released
Walleye	240	151	391	25.3	38.6
Pike	47	63	110	7.2	57.3
Perch	50	67	117	7.6	57.3
Whitefish	16	15	31	2.0	48.4
Rainbow	413	29	442	28.7	6.6
Sauger	50	11	61	3.9	18.0
Goldeye	63	304	367	23.7	82.9
Other*	3	22	25	1.6	88.0
Total	882	662	1544	100	43.0

*Other includes mooneye, saugeye and sucker.

Numbers of fish captured and released on Lake Diefenbaker in 2004 is given in Table 6. Anglers tended to release almost 60% of the pike and perch caught, almost 40% of their walleye, but less than 10% of the rainbow trout captured. Over 80% of the goldeye caught were released. Overall, anglers interviewed at Lake Diefenbaker released 43% of all fish they caught.

Anglers fishing on Lake Diefenbaker in 2004 caught an average of 1.33 fish per day, or 0.45 fish per angler-hour. Fishing success was variable among the many areas fished on Lake Diefenbaker. In terms of number of fish caught per angler-hr, those anglers fishing at Beaver Flats and the Saskatchewan Landing areas enjoyed the best success, capturing 0.68 fish/angler-hr and 0.71 fish/angler-hr (Table 6) respectively. Anglers at Herbert/Prairie Lake Park area had the poorest success, at 0.04 fish per angler-hour. However, few angler interviews were carried out at that site and results may not be representative.

A total of 49 walleye caught by anglers during the summer of 2004 were measured, and average fork length was 44.3 cm. A t test of significance was carried out on the fork lengths of walleye captured above and below Riverhurst. There was no significant difference in sizes of fish between the areas. In the 1983 creel survey carried out on Lake Diefenbaker (Chen 1983), a total of 60 walleye taken by anglers was also measured. Average fork length of fish in that year was 29.8 cm.

Sixty-eight rainbow trout were measured and average fork length of this species was 44.4 cm. Five perch averaged 28.7 cm, 11 pike averaged 47.3 cm, and three sauger averaged 34.2 cm in fork length.

Public Perceptions of the Lake Diefenbaker Fishery

One of the extra questions asked of a sub-sample of anglers was whether their fishing day at Lake Diefenbaker met their expectations (Appendix 7). A total of 22 anglers said yes that it did. Twenty two anglers also indicated that their fishing trip did not meet their expectations. Common responses for a positive experience included catching fish, first time fishing Lake Diefenbaker so didn't know what to expect, only fished briefly and caught fish. The most common reason for a poor experience was lack of success in catching fish, poor fishing, no one comes here, and slower that usual.

Anglers relayed many comments during their interviews at Lake Diefenbaker in 2004 (Appendix 7). Comments varied from a great fishing experience, caught walleye limit, catches 50-70 walleye on a good day to statements such as fishing was poor and the walleye were small, no pike in the lake, and walleye numbers down. A common statement was that ice fishing was too dangerous due to variable ice conditions. The majority of anglers who were asked what species they preferred to catch indicated walleye, followed by rainbow. Many stated a distaste for goldeye, commenting that they were greasy.

Forty-eight anglers were asked how many days they spent angling on Lake Diefenbaker in 2003 (Appendix 7). The majority (37.5%) fished between one to ten days, and 27.1% fished between 10 and 25 days. Approximately 20% did not fish on Lake Diefenbaker at all in 2003, whereas 16.7% fished more than 25 days.

Catch Comparison with Earlier Surveys

Table 8 gives a comparison of angling success for three different years when creel surveys have been carried out on Lake Diefenbaker. The 1983 results were calculated from a subsample of 444 anglers that were interviewed during that year. The 1984 information was generated from the estimated total catch of all anglers fishing on Lake Diefenbaker from June 1 to August 31. The table suggests that angling success was similar for anglers interviewed in 1983 and 2004, with 1.38 fish and 1.33 fish caught per angler hour respectively. However, species composition in the creel has changed, with a shift towards

Table 8. Catch rates for five species of gamefish captured in Lake Diefenbaker during three years of creel survey, 1983, 1984 and 2004. Other species have not been included in the table.

		1983*	1984**	2004
Walleye	No. caught	404		391
	No. /angler	0.91	3.09	0.34
	No./angler-hr	0.35	0.85	0.11
Pike	No. caught	111		110
	No. /angler	0.25	0.50	0.10
	No./angler-hr	0.10	0.14	0.03
Sauger	No. caught	2		61
	No. /angler	0.01		0.05
	No./angler-hr	0.002		0.02
Rainbow trout	No. caught	1		442
	No. /angler	0.002		0.38
	No./angler-hr	0.001		0.13
Goldeye	No. caught	23		367
	No. /angler	0.05		0.32
	No./angler-hr	0.02		0.11
Total	No. caught	611		1544
	No. /angler	1.38	6.20	1.33
	No./angler-hr	0.53	1.72	0.45

* Information determined from a subsample of 444 anglers interviewed in 1983 (Chen 1983).

** Information based on the estimated total catch of fish from 1200 anglers interviewed in 1984 (Merkowsky and Chen 1985) higher catches of rainbow trout and goldeye. Success for sauger and pike has remained poor, whereas walleye catches have declined. The 1984 creel survey suggests that walleye catches during that year were higher than reported in the other two angler surveys.

Anglers at Lake Diefenbaker in 2004 caught an average of 0.45 fish per angler-hr. As compared to other water bodies in central Saskatchewan, anglers at Lake Diefenbaker have intermediate success in capturing gamefish:

Waterbody	Year	Fish caught/ Angler-hr	Source
Fishing Lake	2000	2.1	Merkowsky 2005
Diefenbaker Lake	1984	1.72	Merkowsky & Chen 1985
Tobin Lake	1981	0.9	Durbin 1981
Diefenbaker Lake	1983	0.53	Chen 1983
Diefenbaker Lake	2004	0.45	Present Study
Last Mountain Lake	2003	0.37	Kuntz 2007
Blackstrap Lake	1995	0.36	Fishing for Tomorrow 1995

DISCUSSION

Limnological parameters have remained relatively constant since the formation of the reservoir in the 1960s. The temperature regime indicates that the upstream areas warm earlier than most areas and show a gradual cooling within the water column. The open lake areas such as Riverhurst, Elbow and Gardiner Dam areas tend to warm slower, and due to the increased depth illustrate more change in temperatures within the column. Waters over 30 m deep tend to have water temperatures in the range of 10°C. These results are similar to parameters measured by Royer (1972).

Oxygen readings taken in 2004 were all over 5 mg/L, even near the bottom stations, although the maximum depth that readings were taken was 30 m. Oxygen conditions have improved in the bottom waters since Royer (1972) carried out the original survey in 1967-69: during this time concentrations of 2.3 to 4.3 mg/L were measured. Newly formed reservoirs often have high levels of biological oxygen demand as flooding can result in large influxes of organic detritus and nutrients from the inundated reservoir basin (Kimmel and Groeger 1986).

Monitoring of water quality in the upper South Saskatchewan River and Lake Diefenbaker during 1984-85 indicates that most reaches of the reservoir were considered mesotrophic, or moderately productive (SEPS/EC 1988). Nutrient levels were consistently higher in the shallower upstream locations. The Danielson reach near Gardiner Dam was considered oligotrophic, indicating low amounts of nutrients and productivity. Analyses of sediment cores taken from Lake Diefenbaker in 1995 revealed that the reservoir exhibited three stages of production (Hall et al. 1999). In the initial four years, nutrient levels were high and were likely

enhanced by nutrients from the flooded soils and erosion of littoral zone material. Changes after about 1972 shifted to a period of reduced reservoir production that lasted at least 10 years. Since 1986, there appears to have been a gradual shift to more productive conditions.

Similar to the findings in 1967-1969, water clarity is less in the upper reaches of the reservoir which are influenced by inflows from the South Saskatchewan River. Few secchi readings were taken during the 2004 study so it is difficult to compare results from the different years of survey. The suspended particles transported into Lake Diefenbaker from the tributaries settle out as flows cease. Highest sediment deposition occurs in the upper portions of the basin, as evidenced by reduced clarity in the Saskatchewan Landing area. Basin filling by siltation is increased particularly when reservoirs are located in erodible watersheds (Kimmel and Groeger 1986). Shoreline erosion rates for Lake Diefenbaker have been predicted in the range of 1-3 m/yr (Hall et al. 1999), although higher rates up to 6 m/yr were observed from 1968 to 1992 (Penner 1993). Factors affecting erosion are type of material, wind and wave energy, and age of the reservoir. Materials occurring around Lake Diefenbaker offer different resistances to erosion, with sand and gravel being highly erodible over the short term.

Most species of fish show some preference to water temperature and require suitable oxygen conditions. Both these factors can restrict the water depths that are suitable for the survival of a particular species. Additionally, reservoirs differ from natural lakes in several important ways. Water levels fluctuate more often and more vertically, which can lead to:

- Limited habitat of submerged or emergent aquatic vegetation;
- Exposure and desiccation of fish eggs during incubation, particularly over-winter;
- Shorelines subject to erosion and thus increasing turbidity and sedimentation.

These factors as well as amount of areas with appropriate temperature and oxygen regimes can have an effect on the success of a particular fish species. Additionally the residence time of water in reservoirs can be short, with a quick flushing time. Rapid flushing does not allow nutrients to be utilized effectively by phytoplankton, zooplankton and then fish, resulting in fairly unproductive systems as opposed to natural lakes. In a reservoir such as Lake Diefenbaker, continued erosion of shorelines (particularly sandy or till materials) can bury organic soils, strong winds on exposed areas reduce rooted aquatic vegetation and benthic populations, and result in a reduction in fish productivity (Hall et al. 1999).

Freshwater fish can be classified into three categories, warm, cool and cold, based on temperature preferences. There are several methods of classification, but in general much of the literature recognizes groups with the following preferred temperatures: (OMNR 2004, Coker et al. 2001):

Warm water fish	> 21 to 25°C
Cool water fish	18 to 21-25°C
Cold water fish	< 18°C

With the temperature observations made in 2004 as well as those collected during earlier surveys, Lake Diefenbaker is suitable for cold and cool-water fish species. Marginal habitat may be available for warm water fish. Large-bodied fish collected from Lake Diefenbaker during 2004 can be categorized:

Classification	Species	Preferred Temperature, °C*
Cold	Longnose sucker	8-17
	Cisco	13-18
	Lake whitefish	12.7
	Rainbow trout	11.3
	Lake trout	10.0
Cold/cool	Lake sturgeon	15-17
	Burbot	21.2
Cool	Quillback	22.1
	White sucker	22.4
	Silver redhorse	unavailable
	Northern pike	22.5
	Yellow perch	21.4
	Sauger	19.2
	Walleye	22
Cool/warm	Mooneye	22-27
Warm	Goldeye	27-29
	Shorthead redhorse	26-27.5

*Based on preferred summer water temperatures, and as assigned by Coker et al. (2001).

Summer temperatures in Lake Diefenbaker are predominantly suitable for cool and cold-water fish species. Certain species, such as lake trout, are restricted to areas where water temperatures remain about 10°C. Other cold water fish such as whitefish, are more adaptable and successfully survive at water temperatures over 20°C, as evidenced by their occurrence in lakes like Jackfish Lake and Lac Pelletier (J. Merkowsky, pers ob). However, their preference for cooler waters is

shown by their distribution in the 2004 gillnet catches: the majority of whitefish were taken in nets that were set deeper than 15 metres and thus cooler than 18°C.

Walleye is considered a cool-water fish, preferring temperatures around 20°C. Over 90% of the walleye were captured in gillnets that were set in waters less than 15 metres deep. About 23 400 ha in Lake Diefenbaker is shallower than 15 m (49% of the lake at full supply) and would provide suitable habitat for walleye (Royer 1972).

Walleye spawning habitat, preferentially course gravel and cobble, is commonly found in Lake Diefenbaker. Coteau Bay provides an important area for reproduction and rearing. The shallow and protected nature of this bay allows it to warm up faster than the open water areas of the main lake. Other spawning areas where walleye eggs were collected during previous assessments include Aiktow Creek, Summit Creek, Hitchcock Bay and Sage Bay. Swift Current Creek had previously been identified as an important spawning area (Chen et al. 1984). However, estimated abundance of walleye was much greater in Coteau Bay than at other locations (Wallace and Jensen 2004).

The distribution of sauger in the reservoir is predominantly in the Saskatchewan Landing areas of the reservoir. Almost 90% of the sauger were captured in nets set above Riverhurst during the 2004 survey. This species is more successful in a riverine environment than walleye as it appears to adapt more readily to turbid conditions found in river systems (Scott and Crossman 1973). Sauger appear to prefer spawning habitat with flowing water, warmer temperatures and high physical turbidity (Graeb 2006), which would predominantly be found in the upper reaches of Lake Diefenbaker.

Walleye and sauger are known to hybridize naturally within Lake Diefenbaker. Visual identification of morphologic features was not reliable in determining hybrids, particularly with fish smaller than 200 mm (Flammang and Willis 1993). The rate of hybridization in Lake Diefenbaker, at 22% overall, is relatively high when compared to other lakes and reservoirs that typically are 2 to 4% (Billington et al. 2005). Higher rates have occasionally been reported. For example, in Lewis and Clark Lake, a mainstem reservoir on the Missouri River, over 20% of the *Sander* specimens were hybrids (Graeb 2006). The reason for the high rate of hybridization in Lake Diefenbaker is unknown. The highest rate of hybridization was in the upper, riverine reaches of the reservoir. Walleye taken from downstream areas do not appear to be hybrid individuals. This is an important consideration due to the spawn camp that operates annually on Coteau Bay which relies on pure walleye for brood stock.

In many reservoirs, sauger populations experience declines across much of their range, with factors such as hybridization, exploitation, loss of spawning areas and general habitat alterations associated with regulated rivers contributing to the decline (Graeb 2006). However, in Lake Diefenbaker, sauger populations appear to be relatively stable.

The majority of goldeye were also captured in nets above Riverhurst. Warmer water temperatures in the upper reaches of the reservoir may have had an influence on this warm-water species. Goldeye are largely a riverine species, adapting well to turbid waters which are predominantly found in the upstream areas of the reservoir. In the initial assessment of Lake Diefenbaker, goldeye were distributed throughout the reservoir during the first year of study, but in following years appeared to have become concentrated in the upper, more river-like areas (Royer 1972).

Factors other than temperature and oxygen may influence fish behaviour and successful establishment of a species. Draw down of the reservoir has likely had a substantial impact on the reproductive success of fall spawning fish. Average maximum over-winter drawdowns from 1968 to 2003 were 5.4 m after October 1st, and 4.3 m after December 1st. Average drawdowns were greater after October than December in every decade, by about 1 to 1.5m. Therefore any effects of drawdowns on eggs would be somewhat greater for early-fall spawning fish as opposed to late-fall spawners.

In particular, this annual event appears to have affected lake trout, which spawn on rocks and shoals where wave action keeps the eggs aerated. Lake trout typically spawn in waters approximating 8°C, which is usually mid-September to October in larger lakes (Scott and Crossman 1973). Suitable spawning habitat below the drawdown level and thus available for overwintering tends to have an accumulation of silt, which would suffocate the developing eggs. However, some successful reproduction must be occurring, as lake trout are still captured in both gillnets and by anglers, and lake trout have not been stocked since 1975.

Whitefish and cisco are also fall-spawning species, and both have become successfully established in Lake Diefenbaker. Lake whitefish spawn later in the year when water temperatures approach 3°C, generally late November to mid-December. Furthermore, whitefish are more adaptable with regard to spawning substrates and are able to reproduce in areas other than rock shoals. In Jackfish Lake they tend to spawn along the east and south shores, in areas of sand, coarse sand and gravel (Liaw 1978). This type of substrate is fairly common in Lake Diefenbaker. In past years, a commercial fishery for whitefish operated in the fall (from 1976 until 1985) and targeted the spawning fish. Tagging surveys indicated that

whitefish tended to move towards Saskatchewan Landing in the fall for spawning, with fewer numbers moving towards Coteau Bay (Chen 1992). It appears that the reservoir provides ample whitefish habitat with suitable water temperatures, adequate oxygen and appropriate spawning and rearing areas.

Northern pike require flooded vegetated areas in which to lay their eggs. Drawdowns in early spring tend to leave coulees dry, and areas suitable for this species to reproduce appear to be limited. Water levels do not rise until late June or July to flood terrestrial sites so these areas remain unusable in most years. Eroding shorelines do not allow for rooted vegetation to become established. There are several tributaries flowing in to Lake Diefenbaker which may provide some suitable habitat. The amount and suitability of spawning and nursery habitat for northern pike has declined in Lake Diefenbaker since its creation.

Although perch tend to require vegetation in order for successful reproduction to occur, some spawning occurs over sand or gravel (Scott and Crossman 1973). The egg mass, in a long accordion-like string, undulates with water movements while attached to vegetation or to the bottom substrate. This species has become successfully established in Lake Diefenbaker, so natural reproduction is occurring within the reservoir or in the few tributaries.

In the first survey of Lake Diefenbaker, a single (female) rainbow trout was caught in a gillnet set near Elbow. During the 1980s, a "sparse population" of spring-spawning rainbows resided in the lake and river system (Young 1989). Small numbers were caught in trapnets in the mouth of Swift Current Creek, by angling, and in commercial and lake survey gillnets. In general, the introduced rainbow trout show limited reproduction in Lake Diefenbaker because of lack of suitable spawning and rearing habitat: rainbows typically spawn in redds among gravel or cobble in riffle areas of creeks.

In the 1980s, rainbow trout fry and fingerlings stocked into Richardson Creek demonstrated survival in to autumn, but little spawning habitat was available (Young 1989). A number of other creeks in the western end of the reservoir were examined for spawning suitability. Swift Current Creek had potential in terms of reasonable flows and gravel substrate, but summer water temperatures were too warm for fingerling survival (Al McCutcheon, pers. comm.). Other smaller creeks were too intermittent to provide suitable habitat.

Unintentional escapes of rainbow trout from the existing aquaculture operation in 1994 and again in 2000 provided increased angling opportunities for this species. The trout raised in the aquaculture cages are triploid, and thus unable to reproduce even if suitable spawning habitat

was available. Some concern was raised by anglers on potential impacts of the escaped trout on native fish stocks in the reservoir, particularly with regard to the walleye. The length-weight regressions indicated that growth rate of the various gamefish has not changed since the 1983 survey. The heavier relative weight exhibited by the walleye captured in 1995 is unknown. The trout that escaped in 1994 were catchable size and thus would be too big to provide an additional food resource.

Research in the experimental lake system in Ontario suggests that rainbow trout from aquaculture situations do not exhibit a good survival rate upon their release (C. Podemski, pers. comm.). Catches of rainbow trout in gillnets set in 2004 was low, yielding only 7 fish which suggests low abundance and distribution of this species. However, gillnets set on the bottom are not as effective in capturing rainbows as are nets set on the surface (Bryan 1995). The capture of numerous rainbow trout by anglers suggests that this species is more abundant in the reservoir than gill net results suggest.

Lake Diefenbaker provides opportunity for anglers to capture numerous species of fish. The creel survey carried out in 2004 reveals that angling success and type of fish are affected by location, with anglers fishing the Saskatchewan Landing area enjoying the most success. Overall, walleye, rainbow trout and goldeye each made up approximately 25% of the total angler's catch. Walleye captured by anglers in the 2004 survey were substantially larger than walleye measured in the 1983 creel survey.

There has been a shift in species captured by anglers since the reservoir impoundment. During 1983 and 1984, walleye comprised the majority of fish caught. In the initial angler survey carried out in 1969, northern pike was the main species taken (Royer 1972).

During the 1969 survey, approximately 3 hours were required to capture each fish with catch per hr varying from 0.33 fish/hr during June to 0.29 fish/hr in July (Royer 1972). Although angler success remains relatively low in Lake Diefenbaker as compared to several other southern waterbodies, the catch rate has remained fairly constant. In terms of fishing pressure, the 2000 Survey of Sport Fishing in Saskatchewan lists Lake Diefenbaker as the top destination for angling (Duffy 2006). However, in terms of angler pressure per hectare, Lake Diefenbaker ranks relatively low. The 2000 Survey of Sport Fishing in Saskatchewan estimated that a total of 28 877 anglers fished at Lake Diefenbaker in 2000, which is approximately 0.6 anglers/ha, whereas; an estimated 9076 anglers fished on Blackstrap during the same year, at 7.6 anglers/ha. Thus in terms of fishing pressure per area, Lake Diefenbaker does not appear to be heavily exploited.

CONCLUSIONS

- No major changes have occurred to the physical or chemical parameters of Lake Diefenbaker over the last few surveys. Indications are that the water quality has improved with respect to oxygen levels since the formation of the reservoir.
- Surveys suggest that the species of fish occurring in Lake Diefenbaker has remained similar since its formation; however there has been a shift in the relative abundance of species as well as in the distribution within the lake.
- Walleye appear to have declined in abundance since 1992. However, results must be interpreted with caution as during the 2004 survey, no nets were set in the Qu'Appelle arm or in the section between Riverhurst and Elbow; areas that numerous walleye were taken in past survey nets. Length distribution, age and growth analyses suggest that the walleye population remains in a healthy, stable state.
- Although sauger populations are known to decline when impoundments occur, this species appears to have stabilized in Lake Diefenbaker. Distribution of sauger has changed from occurring throughout the reservoir in the early years following its formation, to becoming concentrated in the upper, more riverine areas.
- A high degree of walleye – sauger hybridization occurs within Lake Diefenbaker, with the highest rates occurring in the upper areas.
- Lake whitefish populations are abundant in the reservoir. Distribution of this species is widespread in the reservoir as they were taken in every gillnet set in 2004. The majority of fish were caught in the areas where nets were deeper than 10 m, suggesting the preference of whitefish for cooler water.
- Results suggest that rainbow trout are sparsely distributed in Lake Diefenbaker, although gillnetting techniques may have underrepresented the abundance of this species. Based on analyses of 2004 data, and comparisons with earlier surveys, the incidental trout releases do not appear to have made an observable impact on native fish populations.
- Low numbers of pike were taken in the gillnets, similar to results obtained in the last few surveys. This species has shown a decline in abundance since reservoir formation when it was the most frequent fish taken by angling. Limiting spawning habit is likely the contributing factor to the low levels of abundance. However, although the numbers appear sparse, this population appears to have reached a stable level.
- Goldeye numbers, although slightly increased from the last survey, remain relatively low in terms of catch composition in the gillnets. Distribution has changed from being dispersed throughout the river system during early years of impoundment to being restricted to the

upper reaches of the reservoir. Alternatively, although low in numbers, the mooneye is widespread throughout Lake Diefenbaker.

- Perch were taken in the majority of gillnets set in 2004, suggesting this species occurs throughout the reservoir. Although not a major component of the angler's creel, this species is important as a prey species for other gamefish.
- Lake sturgeon numbers remain sparse, and are largely restricted to the upper, more riverine areas of Lake Diefenbaker.
- Sport harvests on Lake Diefenbaker currently focus on walleye, rainbow trout and goldeye, with each species contributing roughly 25 % of the angler's creel. Overall there has been a shift from high catches of pike during the early years of reservoir development to high numbers of walleye, to the present combination of walleye (and sauger), rainbow trout and goldeye.
- Although Lake Diefenbaker is popular with anglers, given the numbers of anglers per hectare, the reservoir does not appear to be overexploited.

MANAGEMENT RECOMMENDATIONS

1. Overall, the focus of fisheries management should be toward the maintenance and sustainability of the native fish species. However, the unintentional release of rainbow trout from the existing aquaculture facility must be acknowledged and incorporated into the overall management plan for Lake Diefenbaker.
2. The Ministry of Environment is working on a Fisheries Management Plan for the province, therefore, no changes to the recreational fishery are recommended at this time.
3. The importance of maintaining the sustainability of the walleye population, particularly with regard to the annual spawn camp operation, is paramount. Therefore monitoring the spawning run of fish, as well as assessing and monitoring the percentage of hybridization of walleye and sauger, must remain a focus of the management plan for Lake Diefenbaker.
4. Walleye stocking in the Saskatchewan Landing area of Lake Diefenbaker has been occurring annually since 2004. Within the next two to three years, a reassessment of fish populations in Lake Diefenbaker should be carried out, with an emphasis placed on determining the success of this stocking program.
5. Minimal information is available on the plankton and benthic productivity of Lake Diefenbaker since the initial survey was carried out between 1967 and 1969. If resources are available, an assessment of these indicators should be carried out in coordination with the fisheries survey. The forage fish base should also be surveyed.
6. If opportunities are available, continued investigation should occur with regard to providing fish access up the tributaries to Lake Diefenbaker. Such activity could enhance the spawning opportunities for pike.
7. Periodic angler surveys should be carried out to assess fishing pressure on the reservoir as well as inventory the catch rates and species composition of the creels.

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Appendix 1. Stocking records for Lake Diefenbaker 1969 to 2004.

SPECIES	DATE	AMOUNT	SIZE
BROOK TROUT	30/06/1987	150	CATCHABLES
BROWN TROUT	30/06/1987	150	CATCHABLES
LAKE TROUT	10/04/1970	66000	FINGERLING
LAKE TROUT	30/04/1970	60000	FINGERLING
LAKE TROUT	06/05/1970	60000	FINGERLING
LAKE TROUT	12/05/1970	57000	FINGERLING
LAKE TROUT	19/05/1970	39000	FINGERLING
LAKE TROUT	22/05/1970	46000	FINGERLING
LAKE TROUT	02/06/1970	46000	FINGERLING
LAKE TROUT	04/06/1970	47000	FINGERLING
LAKE TROUT	16/06/1970	48000	FINGERLING
LAKE TROUT	18/06/1970	47000	FINGERLING
LAKE TROUT	23/06/1970	42000	FINGERLING
LAKE TROUT	24/06/1970	14000	FINGERLING
LAKE TROUT	13/04/1971	55000	FINGERLING
LAKE TROUT	20/04/1971	55000	FINGERLING
LAKE TROUT	04/05/1971	34000	FINGERLING
LAKE TROUT	07/05/1971	30000	FINGERLING
LAKE TROUT	12/05/1971	40000	FINGERLING
LAKE TROUT	28/05/1971	18000	FINGERLING
LAKE TROUT	11/06/1971	30000	FINGERLING
LAKE TROUT	15/06/1971	33000	FINGERLING
LAKE TROUT	24/06/1971	35000	FINGERLING
LAKE TROUT	29/06/1971	40000	FINGERLING
LAKE TROUT	01/04/1975	70000	FINGERLING
LAKE TROUT	03/04/1975	76000	FINGERLING
LAKE TROUT	08/05/1975	34000	FINGERLING
LAKE TROUT	15/05/1975	36000	FINGERLING
LAKE TROUT	27/05/1975	34000	FINGERLING
LAKE WHITEFISH	24/03/1969	1250000	FRY
LAKE WHITEFISH	21/04/1969	1500000	FRY
LAKE WHITEFISH	23/04/1969	1000000	FRY
LAKE WHITEFISH	25/04/1969	250000	FRY
LAKE WHITEFISH	04/05/1972	1600000	FRY
LAKE WHITEFISH	05/05/1972	1600000	FRY

Appendix 1. continued			
SPECIES	**DATE**	**AMOUNT**	**SIZE**
LAKE WHITEFISH	09/05/1972	1050000	FRY
RAINBOW TROUT	19/05/1987	35863	FINGERLING
RAINBOW TROUT	19/05/1987	247400	FINGERLING
RAINBOW TROUT	19/05/1987	60720	FINGERLING
RAINBOW TROUT	19/05/1987	10261	FINGERLING
RAINBOW TROUT	19/05/1987	158451	FINGERLING
RAINBOW TROUT	19/05/1987	7168	FINGERLING
RAINBOW TROUT	30/06/1987	150	CATCHABLES
RAINBOW TROUT	17/05/1988	75	CATCHABLES
RAINBOW TROUT	15/06/1988	44000	FRY
RAINBOW TROUT	29/06/1995	15000	FRY
RAINBOW TROUT	29/04/1996	30000	FRY
RAINBOW TROUT	20/04/1998	88000	EYED EGGS
RAINBOW TROUT	21/01/1999	165000	EYED EGGS
RAINBOW TROUT	15/04/1999	30000	FRY
RAINBOW TROUT	25/02/2004	370000	FRY
RAINBOW TROUT	21/04/2004	100000	FRY
PIKE	22/06/2000	3300	FINGERLING
PIKE	17/05/2001	25000	FRY
PIKE	28/05/2003	60000	FRY
WALLEYE	28/05/1969	1250000	FRY
WALLEYE	31/05/1969	1250000	FRY
WALLEYE	05/06/1969	1000000	FRY
WALLEYE	10/06/1970	500000	FRY
WALLEYE	15/06/1970	1500000	FRY
WALLEYE	17/06/1970	1000000	FRY
WALLEYE	02/06/1971	1000000	FRY
WALLEYE	04/06/1971	1500000	FRY
WALLEYE	06/06/1975	1000000	FRY
WALLEYE	10/06/1975	2000000	FRY
WALLEYE	31/05/1984	1000000	FRY
WALLEYE	29/05/1985	250000	FRY
WALLEYE	20/05/1987	800000	FRY
WALLEYE	21/05/1988	300000	FRY
WALLEYE	24/05/1988	500000	FRY
WALLEYE	13/05/1991	3080000	GREEN EGGS
WALLEYE	03/06/1991	2300000	FRY

Appendix 1. continued			
SPECIES	**DATE**	**AMOUNT**	**SIZE**
WALLEYE	14/05/1993	500000	FRY
WALLEYE	31/05/1993	2250000	FRY
WALLEYE	20/05/1994	3000000	FRY
WALLEYE	30/05/1995	3450000	FRY
WALLEYE	03/06/1996	3500000	FRY
WALLEYE	23/05/1997	2170000	FRY
WALLEYE	02/06/1997	1200000	FRY
WALLEYE	22/05/1998	3500000	FRY
WALLEYE	22/05/1999	3000000	FRY
WALLEYE	01/06/1999	3000000	FRY
WALLEYE	21/05/1999	1500000	FRY
WALLEYE	31/05/2000	2000000	FRY
WALLEYE	25/05/2001	100000	FRY
WALLEYE	05/06/2001	3600000	FRY
WALLEYE	30/05/2002	1000000	RY
WALLEYE	31/05/2002	700000	FRY
WALLEYE	16/06/2002	3500000	FRY
WALLEYE	23/05/2003	350000	FRY
WALLEYE	22/05/2003	500000	FRY
WALLEYE	01/06/2003	4000000	FRY
WALLEYE	23/05/2004	1000000	FRY
WALLEYE	20/05/2004	400000	FRY (SK LANDING)
WALLEYE	01/06/2004	1600000	FRY
WALLEYE	03/06/2004	600000	FRY (SK LANDING)
WALLEYE	05/06/2004	1900000	FRY

Appendix 2. Days during the summer of 2004 that the various locations of Lake Diefenbaker were checked by the surveyors. Dates in bold-italics are weekends or designated statutory holidays.

		Cangro	Coteau	Danielson	Elbow	Douglas	Hitchcock	Riverhurst	Herbert	Beaver	Sk Landing	No. anglers contacted
May	21	+	+	+			+	+	+			17
	22		+		+	+					+	53
	23										+	13
	24	+	+	+	+	+	+	+	+	+		86
	25							+				10
	29		+	+			+	+				20
	30	+				+	+					25
June	9				+	+				+		3
	10	+						+		+	+	1
	11		+	+			+	+			+	14
	12				+	+		+	+			5
	13	+	+				+	+			+	65
	14										+	9
	19										+	51
	20									+	+	47
	30	+	+				+	+	+			12
July	***1***			+	+	+		+				47
	2	+	+	+			+		+	+		41
	3		+	+	+	+					+	89
	4	+	+				+					12
	10		+	+			+	+				125
	11		+		+	+		+				67
	21								+		+	7
	22		+			+	+			+	+	14
	23			+	+	+					+	41
	24	+					+		+	+		27
	25		+	+	+			+				64
	26	+				+		+				8

Appendix 2 continued

		Cangro	Coteau	Danielson	Elbow	Douglas	Hitchcock	Riverhurst	Herbert	Beaver	Sk Landing	No. anglers contacted
August	5	+	+	+			+					13
	6			+	+	+						8
	7	+	+				+				+	25
	8	+	+	+			+				+	6
	11										+	11
	12								+	+	+	8
	13							+				8
	14		+	+			+	+	+		+	45
	15				+	+					+	64

Appendix 3. Angler interview form used in 2004.

Saskatchewan Environment

ANGLER INTERVIEW — DIEFENBAKER 2004

INTERVIEW PLACE_____ DATE & TIME 2004 _____ am / pm

NUMBER IN PARTY FISHING TODAY_____ = MALES_____ + FEMALES_____

+ M<16_____ + F<16_____

HOURS FISHED TODAY: _____ ANGLERS @ _____ HOURS = _____

BOAT or SHORE _____ ZONES FISHED_____ _____ _____ _____

PLAN TO FISH REST OF TODAY: _____ ANGLERS @ _____ HOURS = _____

or SPECIES _____ UP TO _____ HOURS / CAUGHT / KEPT

ANY FISH CAUGHT? YES / NO ____

SPECIES	NUMBER CAUGHT BY PARTY	NUMBER KEPT BY PARTY	REASON FOR ANY RELEASES
WALLEYE	_____	_____	_____
N. PIKE	_____	_____	_____
PERCH	_____	_____	_____
RAINBOW	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

STAYING THIS TRIP: CMPG___ CABIN___ DAY___ F/F___ HOTEL___

HOME CITY / TOWN / RM:_____

ICE FISH THIS LAKE? YES / NO ___

****

DID FISHING MEET EXPECTATIONS TODAY? Y / N__ WHY/NOT_____

IMPORTANCE TO YOU (very=3, moderate=2, low=1, not at all=0)

ABUNDANCE OF FISH__ (WALL__ PIKE__ PERCH__ RAINBOW__ OTHER_____)

SIZE OF FISH__ (WALL__ PIKE__ PERCH__ RAINBOW__ OTHER_____)

DISTANCE FROM RESIDENCE__ F/F AT LAKE__ OTHER_____

INTERVIEWER and # _____ Fish sizes Y / N-->

Appendix 4. Surface water chemistry and temperature and oxygen readings by depth, for several locations, 2004.

NETSET 2004-01			NETSET ...			NETSET 2004-03		
DATE 2004 Jun-02			DATE 2004 Jun-02			DATE 2004 Jun-03		
SASK LANDING Power Island			SASK LANDING Mouth of Omachi Bay			COTEAU BAY near S shore		
UTM 13U E0294379 N5618912			UTM 13U E0291159 N5616771			UTM13U E0366259 N5679190		
SECCHI 0.8m			SECCHI 0.7m			SECCHI 2.1m		
pH 8.7			pH 8.65			pH 8.5		
CONDY 496uS			CONDY 482uS			CONDY 434uS		
BOTTOM 10.3m			BOTTOM 4m			BOTTOM 15.8m		
DEPTH (m)	TEMP (°C)	OXYGEN (mg/L)	DEPTH (m)	TEMP (°C)	OXYGEN (mg/L)	DEPTH (m)	TEMP (°C)	OXYGEN (mg/L)
0	15.0	9.4	0	14.8	9.6	0	14.0	10.2
1	14.6	9.4	1.5	14.8	9.6	1		
2	14.6	9.4	2.5	14.7	9.7	2	13.0	10.4
3	14.5	9.4	3.5	14.5	9.7	3	12.1	10.5
4	14.5	9.4	...	...	...	4	11.8	10.4
5	14.5	9.4		...	...	5	11.5	10.3
6	14.5	9.4		...	...	6	11.2	10.0
7	14.5	9.4		...	...	7	10.7	9.7
8	14.5	9.4		...	...	8	10.4	9.4
9	14.4	8.4		...	...	9	10.1	9.2
10	14.1	9.3		...	...	10	10.0	9.3
11	...	...		...	...	11	9.7	9.5
12	...	...		...	...	12	9.6	9.6
13	...	...		...	...	...	...	...

Appendix 4. continued

NETSET 2004-15
DATE 2004 Jun-22

SASK LANDING

UTM 13U E314829 N5615796
SECCHI... m
pH 8.1
CONDY 355uS
BOTTOM 17m

DEPTH (m)	TEMP (°C)	OXYGEN (mg/L)
0	15.5	8.3
1	15.5	8.3
2	15.0	8.3
3	15.0	8.2
4	15.0	8.2
5	15.0	8.2
6	15.0	8.2
7	15.0	8.2
8	14.5	8.3
9	14.0	8.6
10	13.5	8.6
11	13.0	8.5
12	12.0	8.5
13	11.5	8.6
14	11.0	8.4
15	11.0	8.0
16	12.0	5.4
17	...	...
18	...	...
19	...	...
20	...	...
25	...	...
30	...	...
31	...	...

NETSET 2004-04
DATE Jun-22 2004

COTEAU BEACH SUBDIV, open lake

UTM 13U E0373141 N5670171
SECCHI... m
pH 8.55
CONDY 427uS
BOTTOM 34m

DEPTH (m)	TEMP (°C)	OXYGEN (mg/L)
0	11.2	11.4
1	10.7	10.5
2	10.4	10.6
3		
4		
5	10.3	10.5
6		
7		
8		
9		
10	10.2	10.4
11		
12		
13		
14		
15	10.0	11.2
16		
17		
18		
19		
20	9.8	11.0
25	9.6	11.3
30	9.2	11.1
31	...	...

NETSET 2004-05
DATE Jun-23 2004

SNAKEBITE BAY, near shore

UTM 13U E346655 N5626001
SECCHI... m
pH 8.69
CONDY 432uS
BOTTOM 9m

DEPTH (m)	TEMP (°C)	OXYGEN (mg/L)
0	12.9	10.2
1	12.8	10.0
2	12.9	9.9
3		
4		
5	12.8	9.8
6		
7		
8		
9	12.6	9.7
	...	...
	...	...
	...	...
	...	...
	...	...
	...	...
	...	...
	...	...
	...	...
	...	...
	...	...
	...	...
	...	...

Appendix 4. continued

NETSET 2004-07
DATE 2004 Jul-13

RIVERHURST, open lake
UTM 13U E360100 562966
SECCHI... m
pH 8.8
CONDY 441uS
BOTTOM19.5 m

DEPTH (m)	TEMP (°C)	OXYGEN (mg/L)
0	17.0	8.8
1	16.8	8.8
2	16.6	8.7
3	16.5	8.7
4	16.4	8.7
5	16.4	8.5
6	16.4	8.5
7		
8		
9		
10	16.5	8.4
11		
12		
13		
14		
15	16.0	9.0
16		
17		
18		
19	12.7	10.0
20	...	...
25	...	...
30	...	...
31	...	...

NETSET 2004-11
DATE Aug-10 2004
.N of ELBOW near E shore
UTM 13U E375824 N5670230
SECCHI... m
pH...
CONDY... uS
BOTTOM 30m

DEPTH (m)	TEMP (°C)	OXYGEN (mg/L)
0	18.0	8.6
1	18.0	
2	17.7	
3		
4		
5	17.3	
6		
7		
8		
9		
10	17.2	
11		
12		
13		
14		
15	16.9	
16	16.1	
17	14.6	
18	14.2	
19	14.0	
20	13.6	9.2
25	12	9.4
30	10.7	8
31	...	...

NETSET ...
DATE Aug-11 2004
GARDINER DAM, open lake
UTM ...
SECCHI... m
pH...
CONDY... uS
BOTTOM 50m

DEPTH (m)	TEMP (°C)	OXYGEN (mg/L)
0	17.7	
1		
2	17.4	
3		
4		
5	17.4	
6		
7		
8		
9		
10	16.6	
11		
12		
13		
14		
15	14.5	
16		
17		
18		
19		
20	12.5	
25	10.7	
30	9.5	
31		

Appendix 4. continued

NETSET ...
DATE 2004 Aug-11
ELBOW midway to BIRSAY, open lake
UTM 13U ROB #WP38/39
SECCHI... m
pH...
CONDY... uS
BOTTOM 46m

DEPTH (m)	TEMP (°C)	OXYGEN (mg/L)
0	17.5	9.4
1	17.5	9.5
2	17.6	
3		
4		
5	17.7	
6		
7		
8		
9		
10	17.7	
15	17.7	9.5
20	16.1	7.8
25	14.3	
30	10.6	
35	10.1	

NETSET ...
DATE 2004 Aug-11
DOUGLAS PARK, open lake
UTM 13U ROB #WP40
SECCHI... m
pH...
CONDY... uS
BOTTOM 15m

DEPTH (m)	TEMP (°C)	OXYGEN (mg/L)
0	18.2	8.6
1	18.1	9.2
2	18.1	10.0
3		
4		
5	18.0	10.7
6		
7		
8		
9		
10	17.9	9.6
15	17.8	7.6
20	...	...
25	...	...
30	...	...
35	...	...

Appendix 5. 2004 Half Standard gang catch analysis by net set and species.

Date	Depth (m)	LKWH	WALL	SAUG	NRPK	CISC	SUCK	BURB	LKTR	GOLD	RNTR	YLPR	MOON	LKST	ATSL	TOTAL
Jun-02	12	10	20	15	2	2	118	0	0	22	0	5	53	5	0	252
Jun-03	5	7	9	6	0	0	56	0	0	3	0	1	2	1	0	85
Jun-04	10	14	3	0	0	20	6	0	0	0	1	0	0	0	0	44
Jun-22	20	48	0	0	0	5	1	0	1	0	0	0	0	0	0	55
Jun-23	10	40	2	10	0	12	27	0	0	0	0	19	0	1	0	111
Jun-24		36	0	2	0	12	12	1	0	0	0	21	0	0	0	84
Jun-22	17	57	2	1	0	37	13	0	0	0	0	2	0	2	0	114
Jun-23		56	0	0	0	4	13	0	0	0	0	0	0	1	0	74
Jun-24	25	52	1	1	0	29	18	0	0	0	0	0	0	2	0	103
Jun-25	7	53	7	8	0	15	20	0	0	1	0	2	2	1	0	109
Jul-13	4	5	17	21	0	0	190	0	0	31	0	4	117	1	0	386
Jul-13	19	39	0	0	0	1	0	0	0	0	0	0	0	0	0	40
Jul-14	14	8	1	0	1	27	3	0	0	0	0	8	0	0	0	48
Jul-14		10	5	4	0	5	12	0	0	0	1	20	0	1	0	58
Jul-14	4	14	2	3	0	11	44	0	0	3	0	2	0	0	0	79
Jul-15	15	27	7	1	7	13	14	0	0	2	0	6	0	0	0	77
Jul-15		58	0	0	0	1	2	0	0	0	0	0	0	0	0	61
Jul-16	50	22	0	0	0	0	0	0	0	0	0	0	0	0	0	22
Jul-21	8	33	2	1	5	17	7	0	0	0	3	20	0	0	0	88
Aug-04	6	2	4	11	0	0	84	0	0	0	0	0	3	3	0	107
Aug-05	8	21	10	0	0	30	35	1	0	3	0	8	0	0	0	108
Aug-06	8	51	5	1	0	3	30	0	0	16	0	4	5	0	0	115
Aug-11	7	5	8	2	4	0	10	0	0	8	1	1	0	0	0	39
Aug-12	12	14	1	0	0	9	21	0	0	0	1	5	0	0	0	51
Aug-25	8	21	1	1	1	28	47	0	0	17	0	53	2	2	0	173
Aug-26	9	3	19	9	1	3	44	0	0	0	0	7	0	1	0	87
TOTAL		**706**	**126**	**97**	**21**	**284**	**827**	**2**	**1**	**106**	**7**	**188**	**184**	**21**	**0**	**2570**

Appendix 5. continued

TOTAL SG Length = 3000

2004SG	per100m	23.5	4.2	3.2	0.7	9.5	27.6	0.1	0.03	3.5	0.2	6.3	6.1	0.7	0.00	85.7
2004SG	% comp	27	5	4	1	11	32	0	0	4	0	7	7	1	0	100
1995 SG	% comp	38	9	1	1	19	20	0	0	1	0	10	1	0	0	100

2004 SG SUCKERS	cn	c	caught	/100m	%comp
WHSC	147	262	409	13	49
LNSC	41	109	150	5	18
QUIL	25	27	52	2	6
SHRD	57	105	162	5	20
SLRD	39	15	54	2	7
TOTAL			827	26	100

1995 SG SUCKERS	caught	/100m	%comp
White	373	11	11
Longnose	135	4	4
Quillback	2	0	0
Shorthead	114	3	3
Silver	59	2	2
TOTAL	683	20	20

Appendix 6. Numbers of anglers contacted at Lake Diefenbaker on weekdays and weekend-holidays in 2004.

	Weekdays			Weekends-holidays		
	No. anglers Contacted	No. days Surveyed	Avg. no. Anglers/day	No. anglers Contacted	No. days Surveyed	Avg. no. Anglers/day
May	27	2	3.5	197	5	39.4
June	39	5	7.8	168	4	42.0
July	73	5	14.6	469	8	58.6
August	73	6	12.2	115	3	38.3
Total	212	18	11.8	949	20	47.5

Appendix 7. Responses to extra questions asked of a sub-sample of anglers during the creel survey on Lake Diefenbaker in 2004.

1. **Did fishing meet your expectations today?**

   Yes = 22 responses

   Comments included:
   - Caught 7 rainbow
   - Good day, caught sauger and goldeye
   - Caught fish
   - First time out so didn't know what to expect
   - Only fished an hour and got a pike

   No =22 responses

   Comments included:
   - No fish caught, or weren't biting
   - No one catches their limit, no fish, no one fishes here
   - Wrong equipment
   - No fish today, but usually catch

2. **How many days did you fish on Lake Diefenbaker in 2003?**

No. days fished	No. anglers Responding	Percent
0	9	18.7
1 – 9	18	37.5
10 – 24	13	27.1
> 25	8	16.7
Total	48	100

3. **Species that anglers prefer to catch on Lake Diefenbaker.**

   22 anglers prefer walleye
   11 like to catch rainbow trout
   8 prefer to capture other species (perch, pike)
   12 anglers dislike catching goldeye

Appendix 7. continued

4. General comments and perceptions on the Lake Diefenbaker fishery.

No problem with the fishery at Lake Diefenbaker.

- Very happy with the fishery
- No problem with walleye fishery
- Catches 50-70 walleye on a good day
- Fishing great, caught walleye limit a week ago
- Perception that rainbows make it harder to catch walleye. Never caught walleye before anyway.
- Has a fish finder, lots of fish, just not biting.

Fishing in last few years was not as good as in past.

- Fishing not good all summer, walleye small.
- Average summer, mostly caught rainbows.
- No pike in lake.
- Fishing was poor.
- Likes trophy fish.
- Pike way down, should have catch and release for pike.
- Slow summer for fishing.
- Walleye numbers down, should have slot limit for walleye and release all over 20 inches.
- Hasn't caught a walleye in entire life at Diefenbaker, likes perch.
- Gas prices too high.
- Lake too dangerous to ice fish.
- Objects to giving fingerlings to China.
- Upset eggs are taken out of lake and not put back in.
- Douglas Park had swimming lessons and staff to clean washrooms.
- Now bad highways and few staff.
- License fees and gas costs up.
- Only gear is affordable.